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† In marine separate.

CORRECTIONS

MONTHLY WEATHER REVIEW:

March, 1924, page 181, flood table, crest stage at Cumberland, Md., recorded as 19.2 feet, should be 16.8 feet.

May, 1924, page 286, flood table, crest stage at Cumberland, Md., recorded as 13.8 feet, should be 12.8 feet.

September, 1925, page 400, 2d column, 4th paragraph from bottom, 4th line, for "771 inches" read "771 millimeters".

October, 1925, page 441, Figure 1, the legend should read: "Tornadoes, inclosed by heavy line; thunderstorms, by broken line".

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THE NORTH-POLAR COVER OF COLD AIR

PRELIMINARY RESULTS FROM THE MAUD EXPEDITION[1]

By H. U. SVERDRUP

In charge of scientific work of the expedition

It is a well-established fact that in mean latitudes the temperature of the air on a calm and clear day in winter is lowest close to the ground and increases with increasing altitude. With weak wind the same inversion may be found, but with strong wind the temperature generally decreases with altitude. The explanation is that the low winter temperatures of the air are brought about by cooling from below and by contact with the surface, which loses heat by radiation. On calm days, or days with very weak wind, a temperature inversion is thus generated, but with stronger wind the temperatures in the lower layers of the atmosphere are smoothed by the forced mixing caused by turbulence, and the normal decrease of temperature with altitude is established.

According to Simpson,[2] these conditions are very marked at the border of the Antarctic Continent. Simpson explains the great and rapid increase of the temperature at the surface, which every wind there brings as the result of the forced mixing of the lower layers. All temperature observations used by Simpson were obtained by balloons on calm days and show an inversion beginning at the ground, but the very rapid increase of temperature which accompanies every wind is evidence that the air becomes intermixed up to great altitudes by the wind.

Over the Polar Sea different conditions are encountered. Here every wind generally brings also an increase of temperature, which undoubtedly is due to the forced mixing of the air directly above the ice, but this mixing never reaches any great altitude and is generally confined to a layer of a thickness under 200 meters. In the present paper the temperatures will be discussed which were observed in the lower layers of the atmosphere over that part of the Polar Sea traversed by the *Maud* during the drift from August, 1922, to August, 1924.

The discussion will be confined to the results from the coldest months, November to March, which were spent during both years in about 75° north latitude and between 155° and 175° east longitude.

The change of temperature with altitude directly above the ice was determined by a resistance thermometer placed at the crow's nest 32 meters above the ice and read simultaneously six times daily with the readings of the thermometers in the meteorological screen 5 meters above the ice. The free-air temperatures were all determined by means of instruments carried by kites, and thus give information above the temperature-distribution during wind only. It must be emphasized here that all numerical values are preliminary and may be slightly changed by the final reduction of the observations.

According to the readings of the thermometer at the crow's nest, the temperature increases with altitude in winter during calm weather or weak winds. Selecting only the cases when "calm" was entered in the records and when the thermometers were read, it is found that the temperature at the crow's nest was higher than in the screen in 39 of 56 cases during the periods November to March. The mean values are: Screen, $t = -32°.4$ C.; crow's nest, $t = -31°.7$ C. During wind the temperature decreases generally in the first 50 to 200 meters above the ice, but this decrease is then followed by a very rapid increase. The first layer, where the temperature decreases, will be called the cold layer, and the second layer with rapid increase will be called the inversion layer. Above the latter the temperature generally increases slowly or remains constant to an altitude of 500 to 1,500 meters, where a new decrease begins. In the periods mentioned 66 kite ascents were made, but in six cases the altitudes reached were too low to reveal the characteristic features which have been described. In the remaining 60 cases the various layers were always well defined, and from the results of these ascents the following mean values have been derived:

Temperature at the ice, −28°.4 C.
Thickness of cold layer, 136 meters.
Decrease of temperature within cold layer, −0°.5 C.
Thickness of inversion layer, 136 meters.
Increase of temperature within inversion layer, 6°.1 C.
Temperature difference, $^{1}1{,}000-{}^{1}0$, 8°.1 C.
Temperature difference, $^{1}1{,}500-{}^{1}1{,}000$, −1°.4 C.
Temperature difference, $2{,}000-{}^{1}1{,}500$, −2°.3 C.

The last three differences have been derived from the ascents during which 1,000, 1,500, or 2,000 meters were reached. The mean velocity of the wind at the ice was 5.0 m/sec. The mean vertical distribution of the temperature with this wind velocity can, according to the above values, be represented by the following figures:

Altitude, (meters)	0	136	272	1,000	1,500	2,000
Temperature °C.)	−28°.4	−28°.9	−22°.8	−20°.3	−21°.7	−24°.0

In Figure 1 this mean temperature-distribution during wind in the cold season is represented graphically. The mean temperatures during calm weather are also entered in this figure by means of the broken line, supposing the temperatures above 272 meters to be the same. It may be remarked that the latter curve has exactly the same appearance as the mean curve obtained from five ascents with captive balloons during calm, cold weather at Cape Chelyuskin in 1910.

[1] Capt. Roald Amundsen's ship, the *Maud*, intentionally forced into the drift ice at Wrangel Island, drifted for two years with the ice fields north of the Siberian coast, and was icebound one year at Bear Islands, 800 miles west of Bering Strait.
[2] British Antarctic Expedition, 1910-1913, Meteorology. Vol. I, Discussion.

The increase of temperature with altitude in calm weather represents nothing unusual, but the characteristic feature met over the region of the Polar Sea here dealt with is that the mixing of the air by wind evidently does not reach great altitudes. The altitude up to which the temperature decreases represents the limit to which the air is intermixed, and the mean value of this altitude is only 136 meters. In 52 of 60 cases this altitude was less than 200 meters, and in no case more than 650 meters.

From the temperature observations alone it can, therefore, be concluded that no great exchange of air takes

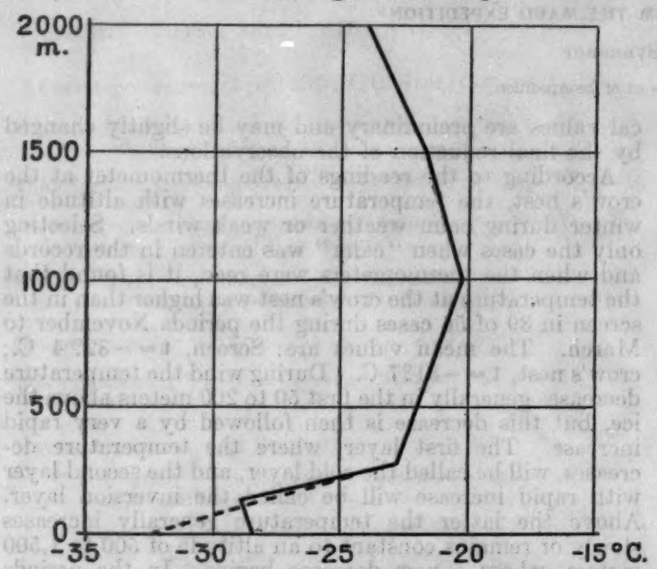

FIG. 1.—Mean temperatures, November to March
———— From kite ascents
— — —, — On calm days

place between the cold layer directly over the ice and the warmer air above it, because such exchange should result in a smoothing of the temperatures, which never has been observed. This means that the cold layer close to the ice represents air which, to a great extent, is isolated from the free atmosphere.

The relations between wind velocity and temperature at the ice and the character of the cold layer have been examined by computing the following correlation factors:

Factor	$r_{v,m}$	$r_{v,t}$	$r_{v,\Delta t}$	$r_{t,m}$	$r_{t,\Delta t}$
Value	+0.40	+0.08	+0.15	+0.02	−0.33

The indices have the following meanings: v, wind velocity at the ice; m, thickness of cold layer; t, temperature at the ice; Δt, difference between the highest temperature observed above the inversion layer and temperature at the ice. This difference will be called the amount of the inversion.

The correlation between the wind velocity and the thickness of the cold layer is the largest, and the positive sign shows that the thickness of the cold layer generally increases with increasing velocity of the wind. This result is in agreement with the conception that the decrease of temperature within the cold layer is due to the forced mixing caused by the rough surface of the ice. With increasing wind this forced mixing increases, and the temperature decrease prevails to greater altitudes. These conditions are represented schematically in Figure 2, where the temperature above the inversion layer is supposed to remain constant and the branches 1, 2, and 3 represent the conditions during calm, moderate wind, and strong wind, respectively.

If the conditions were as simple as represented in this figure, it should be expected that (1) the temperature at the ice would increase with increasing velocity of the wind, (2) the amount of the inversion would decrease with increasing velocity of the wind, (3) the temperature at the ice would increase with increasing thickness of the cold layer, and (4) the amount of the inversion would decrease with increasing temperature at the ice. The various correlation factors have, according to the above compilation, all the expected signs, but are small, except the last. It may here be added that the correlation factor between wind velocity and temperature undoubtedly would be larger if it were to represent all conditions and not only the conditions during the kite ascents. In the present case the primary temperature increase due to the mixing (transition from 1 to 2 or 3 in fig. 2) does not enter.

The circumstance that only the last factor is so large that it may be regarded as representing an actual correlation, seems to indicate that this correlation is connected with conditions which hitherto have been left out of consideration, probably the duration of the wind. A small exchange of air probably takes place between the cold layer and the warmer air above. If the wind continues to blow during a long period, the other conditions remaining unaltered, the temperature of the cold layer must rise on account of this small exchange and the amount of the inversion consequently decrease. Thus a correlation between the named quantities is brought about which is independent of the velocity of the wind.

An examination of the cases in which kite ascents were made on consecutive days during which the direction of the wind was approximately the same, confirms this view. There are eight of these cases resulting from 16 ascents. In five cases the wind was increasing and in three decreasing, and it is found that increasing wind corresponds to increasing thickness of the cold layer and decreasing wind to decreasing thickness, but the tem-

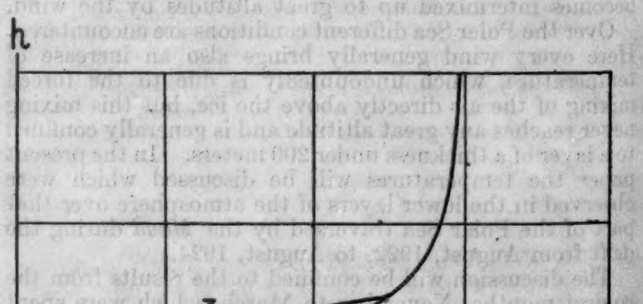

FIG. 2.—Effect of wind on vertical temperature distribution—1, during calm; 2, during moderate wind; 3, during strong wind

perature at the ice is generally higher on the second day and is independent of the change in thickness of the cold layer. This is evident from the following mean values:

	Difference in wind velocity v_2-v_1	Difference in thickness m_2-m_1	t_2-t_1
	M/sec.	*Meters*	*°C.*
Wind increasing	+2.5	+105	+2.4
Wind decreasing	−3.2	−44	+2.3

From the results of the 16 ascents here considered, the following correlation factors have been computed:

Factor	r_{vm}	$r_{v,t}$	$r_{v,\Delta t}$	r_{tm}	$r_{t,\Delta t}$
Value	+0.80	+0.14	−0.15	+0.04	−0.65

As previously stated, only the first and the last are so large that they may be regarded as representing actual correlations. The first must be ascribed to the increased mixing which accompanies the stronger winds; the second, to the small exchange of air which takes place between the cold layer and the warmer air above. This exchange, however, never seems to be so large or to last so long that the air becomes intermixed to great altitudes and the cold layer disappears, because such conditions have not been observed.

The conclusions regarding the exchange of air between the various layers are confirmed by a study of the change of wind direction and velocity with altitude. The wind observations from the free atmosphere were obtained by means of pilot balloons after the one-theodolite method. This method is not entirely satisfactory, particularly for a study of the wind close to the ground, but, as the results from the pilot balloons were in perfect agreement with the experiences regarding the wind conditions gained during the kite ascents, they can be regarded as trustworthy. The simultaneous changes in temperature and wind were studied from several cases in which a pilot balloon was observed shortly before or after a kite ascent.

It is generally found that the wind velocity increases slowly in the lower part of the cold layer and that the direction turns slowly to the right. At the boundary between the cold layer and the inversion layer there is a very rapid increase of the wind velocity and a rapid turning of direction to the right. The velocity generally reaches a maximum within the inversion layer, and above this the velocity as well as the direction of the wind, remains constant, on the average, through several hundred meters.

The cases in which the wind and the temperature-changes were observed practically simultaneously have been divided into two groups according to the thickness of the cold layer, the first containing the cases in which this thickness was less than 100 meters and the second those in which it was between 100 and 200 meters. The mean values of temperature, wind velocity, and turning of wind direction referred to the direction at the ice are entered for various altitudes in Table 1 and represented graphically in Figure 3.

TABLE 1.—*Summary of temperatures (t) and wind velocities (v) for observations at different altitudes (h)*

Group I, altitude less than 100 meters (11 cases)					Group II, altitude 100 to 200 meters (8 cases)				
Temperature		Wind velocity			Temperature		Wind velocity		
h	t	h	v	δ	h	t	h	v	δ
Meters	° *C.*	*Meters*	*M./sec.*	°	*Meters*	° *C.*	*Meters*	*M./sec.*	°
0	−32.0	0	4.7	0	0	−29.2	0	5.5	0
66	−32.0	0–160	10.1	23	153	−29.7	0–150	8.5	16
200	−23.8	160–310	11.3	35	270	−21.9	150–300	13.6	38
560	−21.0	310–470	11.0	36	520	−20.1	300–450	13.4	42
810	−20.7	470–620	10.2	35	980	−19.1	450–600	14.1	38
		620–770	9.6	34			600–750	14.1	38

From Figure 3 it is seen that the changes in temperature and wind within each group have the characteristic features which were described above. The inversion layer, which has been set off in the figure, acts evidently as a sliding surface below which the wind velocities are small on account of the resistance offered by the rough surface of the ice and above which the wind has the character of gradient wind. This circumstance alone is evidence that no considerable exchange of air takes place between the lower cold air and the upper warmer air.

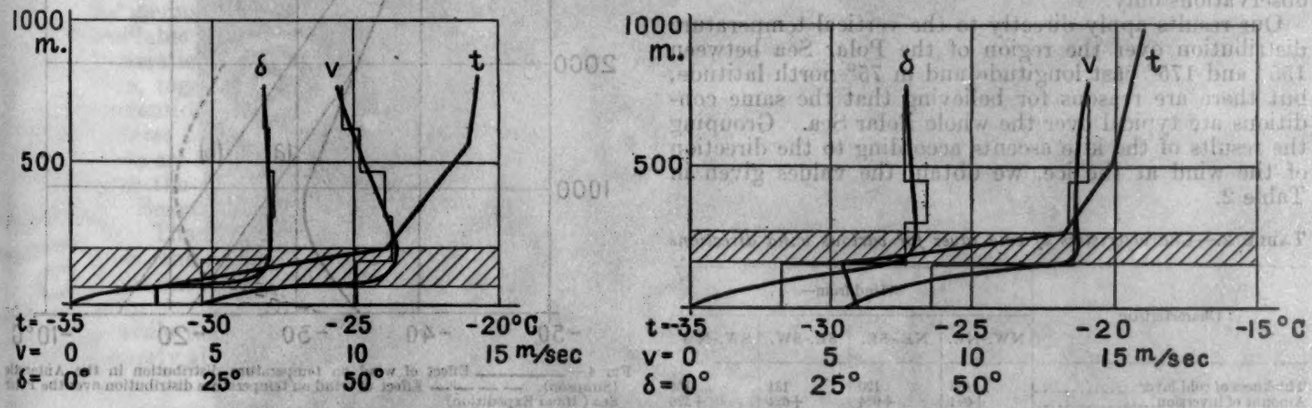

FIG. 3.—Mean values of temperature and wind. Left: Thickness of cold layer less than 100 m. Right: Thickness of cold layer 100 to 200 m.

The exchange of mass between the various layers can, however, be examined more closely by a study of the turbulence. It is well established that the change of the wind with altitude in the vicinity of the ground depends upon the turbulence, for which the coefficient of turbulence is a measure. This coefficient is proportional to the mass of air which per square and time unit is exchanged between two adjacent layers, and thus gives direct information regarding the quantity in which we are interested at present. Hesselberg [1] has developed formulas which permit computation of the coefficient of turbulence from the change of the wind with altitude supposing either the barometric gradient or the gradient wind is known. In the present cases the wind at 500 meters may be regarded as representing the gradient wind, and the coefficient of turbulence can thus be computed by means of the data contained in Table 1. The following mean coefficients have been found within the two groups for the cold layer and the inversion layer; for sake of comparison, the corresponding value for the layer 0 to 500 meters derived from observations from Central Europe [2] has been added.

[1] Über die innere Reibung in der Atmosphäre. *Ann. Hydrogr.*, Berlin, v. 47, 1919 (105–119).

[2] Hesselberg and Sverdrup. Die Reibung in der Atmosphäre. *Veröff. d. Geophys. Inst.*, Leipzig, I.

	Group I		Group II		Central Europe
	Cold layer	Inversion layer	Cold layer	Inversion layer	0-500
Coefficient of turbulence, ν	*C. g. s.* 30	*C. g. s.* 4	*C. g. s.* 100	*C. g. s.* 4	*C. g. s.* 50

From the above it is seen that the coefficient of turbulence is greater within the cold layer, where the value is of the same order of magnitude as found over land in mean latitudes, but within the inversion layer the coefficient in both cases has only one-tenth of the normal value. According to this result, no great exchange of air can take place between the cold layer and the upper warmer air.

The observations with pilot balloons were far more numerous than the kite ascents, and according to them the change of wind with altitude has always the same character if the velocity at the ice is greater than 3 to 4 m./sec. The turbulence, that is, the exchange of air, therefore must have generally the character which was found above, and the wind observations thus confirm the conclusion which was drawn from the temperature observations only.

Our results apply directly to the vertical temperature distribution over the region of the Polar Sea between 155° and 175° east longitude and in 75° north latitude, but there are reasons for believing that the same conditions are typical over the whole Polar Sea. Grouping the results of the kite ascents according to the direction of the wind at the ice, we obtain the values given in Table 2.

TABLE 2.—*Characteristics of cold layer for various wind directions*

Characteristic	Wind from—			
	NW.-NE.	NE.-SE.	SE.-SW.	SW.-NW.
Thickness of cold layer	156	120	131	166
Amount of inversion	+6°4	+9°4	+6°4	+5°6
Mean wind velocity at ice	4.6	5.1	4.8	5.4
Mean temperature at ice	−28.0	−28.3	−28.6	−29.3

The thickness of the cold layer is smallest during easterly winds, when the amount of the inversion is greatest. As the mean wind velocity and temperature at the ice are approximately the same in all groups, this result is practically independent of the correlations previously found.

The fact of greatest interest at present is, however, that the character of the vertical temperature distribution is independent of the direction from which the wind blows, and this is evidence that the same conditions prevail over wide areas. This is confirmed by the results of several ascents with captive balloons and kites performed at Cape Chelyuskin (77° 32′ north latitude, 105° 40′ east longitude) in the spring of 1919, and by the results of kite ascents made during the winter 1924–25 off Bear Islands (70° 43′ north latitude, 162° 25′ east longitude), which all show the same features. Considering the uniform character of the meteorological conditions over the Polar Sea, it seems justified, therefore, to draw the final conclusion that the whole Polar Sea in winter is covered by a thin layer of cold air which, to a great extent, is isolated from the warmer air above. In calm weather or during weak winds the temperature above the ice increases rapidly with altitude because the air is cooled from below. Under these conditions there is no definite transition from the cold to the warmer air, and no exchange of mass takes place between the cold air at the ice and the warmer air above. During stronger winds the cold air is intermixed, and the temperature decreases to an altitude which generally increases with increasing velocity of the wind but seldom surpasses 200 meters. The cold air is then separated from the warmer air above by a sharp layer of inversion through which a small exchange of air takes place.

The temperature distribution during wind, which has been described here, can prevail over a vast plain like the Polar Sea, but not over a continent, where the differences in elevation cause forced vertical movements which finally must result in a complete smoothing of the temperatures in the lower part of the atmosphere and the disappearance of the cold layer developed on calm days. This effect of the wind, which explains the conditions observed at the borders of the Antarctic Continent, has been illustrated by Simpson in a figure which has been reproduced in Figure 4. The thick curve represents the vertical temperature distribution during cold, calm weather as found by balloon observations from Cape Evans, curves (a) and (b) representing the assumed temperature distributions during moderate and strong winds. For comparison, curves 1 and 2, representing the mean temperatures during calm and during a wind of 5 m./sec. over the part of the Polar Sea traversed by the *Maud*, have been entered as broken lines. The different character of the conditions above the Antarctic Continent and the Polar Sea is evident.

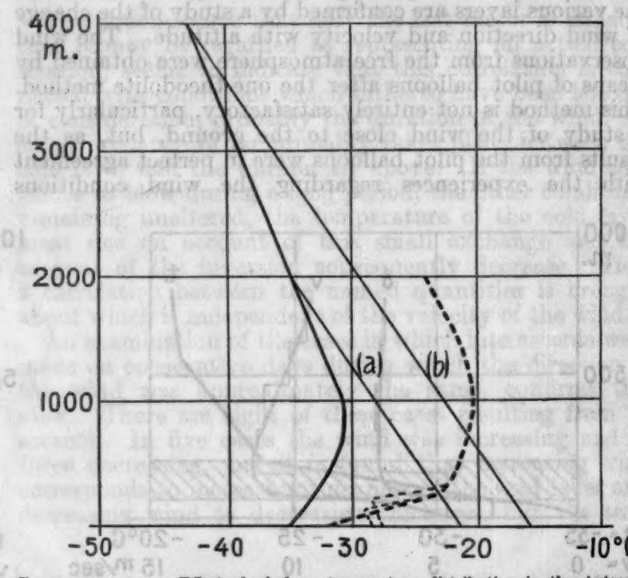

FIG. 4.—_____ Effect of wind on temperature distribution in the Antarctic (Simpson). — — — — Effect of wind on temperature distribution over the Polar Sea (*Maud* Expedition)

We have here dealt only with the conditions in winter. The cold layer over the Polar Sea is, however, developed in the fall and prevails during the greater part of the spring, thus existing through the major part of the year. In July and August a corresponding layer of cold air is developed, at least over the region traversed by the *Maud* and south of it. In these months the ice is melting and the temperature of the air directly above the ice can, therefore, never deviate considerably from 0° C., but above an altitude of 150 to 200 meters the mean temperature according to the kite ascents seems to be higher,

partly on account of convection and partly perhaps on account of direct absorption.

A consequence of these conditions is that a number of the meteorological elements observed at the ice show periodic and unperiodic changes which are of a very local character because they take place within the cold layer directly above the ice. This circumstance seems to be of fundamental importance for the understanding of many of the meteorological conditions over the Polar Sea, and will be taken into account in the fuller discussion of the meteorological observations of the expedition.

METEOROLOGICAL CONDITIONS IN THE EURASIAN SECTOR OF THE ARCTIC

[A summary of the data and conclusions presented by Karl Schneider, A. Berson, L. Breitfuss, M. Robitzsch, R. Süring, A. Wegener, and K. Wegener, in "The airship as a means of exploration in the Arctic." [1]]

By BURTON M. VARNEY

[Weather Bureau, Washington, D. C., November, 1925]

It is perhaps not widely known in this country that an organization called the International Society for the Study of Arctic Exploration by Means of Airships is actively engaged in working toward a solution of this problem. It is composed of some 80 European scientists, including leading meteorologists, oceanographers, geographers, geologists, and polar explorers. Dr. Fridtjof Nansen is its president. There were, at the time the memoir here summarized was published (October, 1924), one American member and no English.

The problem of air navigation in the Arctic is essentially a meteorological one. Hence some 18 pages of the 60-page memoir are devoted to summarizing the pertinent available meteorological data, with special reference to the Asiatic sector. Cloudiness and fog, and wind directions, together with the controls over them, receive major attention.

Cloudiness and fog.—For the area north of 80° the only cloud data are from the traverse of the *Fram* in 1893–1896 from near the mouth of the Lena River to Tromsö in northern Scandinavia. The mean values are set out in Table 1. They indicate clearly a summer maximum of cloudiness, and the fact that the period of the long night had somewhat less than half of the summer amount of cloudiness.

Fog, while showing a summer maximum, was nevertheless nearly absent throughout the autumn, winter, and spring.

TABLE 1

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Cloudiness (1–10)												
3.7	4.4	5.6	5.7	7.2	8.5	8.8	8.8	8.2	6.4	4.4	3.7	6.2
Days with fog												
0	0	2	1	2	10	20	16	10	5	1	0	67

The intensity of development of clouds, fog, and precipitation * * * is, for the polar regions proper, very limited. According to the *Fram* observations the monthly amounts of precipitation were about 3 mm., although in one exceptional case in July there was a fall of 20 mm. in a day. * * * There is no month without snowfall. Rain falls mostly from May to September only, in any case in those areas which lie far from the open sea. The snow cover grows during the course of the winter to a very heavy mass through the condensation of atmospheric moisture on its surface, the temperature of which is mostly below that of the air. This form of precipitation it is not possible to measure. Rime and hoarfrost, on the other hand, while found on a few days, in general are observed only in limited quantity and in regions near the sea. Hoarfrost as we observe it in Europe, is to be classed among the rarities in the Arctic, because the water content of the atmosphere, on account of the low temperature, is so much smaller. The danger of an ice deposit on a traveling airship is therefore less likely than in Europe. An airship journey in the Arctic summer seems, therefore, as far as the meteorological factors are concerned, not seriously more difficult than a similar trip in the European winter.

[1] Published by the Internationalen Studiengesellschaft zur Erforschung der Arktis mit dem Luftschiff, Oct. 7, 1924. (Copy received by the U. S. Weather Bureau Library from the Gesellschaft für Erdkunde, Berlin.)

For the border region of the Arctic in the Eurasian sector, cloudiness data are presented in Table 2 (Franz Josef Land and Spitzbergen), and in the large table at the end of this paper appear data for the five months March–July at 19 stations covering various periods (mostly less than 5 years) from 1 to 33 years. The distribution of these stations is shown in Figure 1.

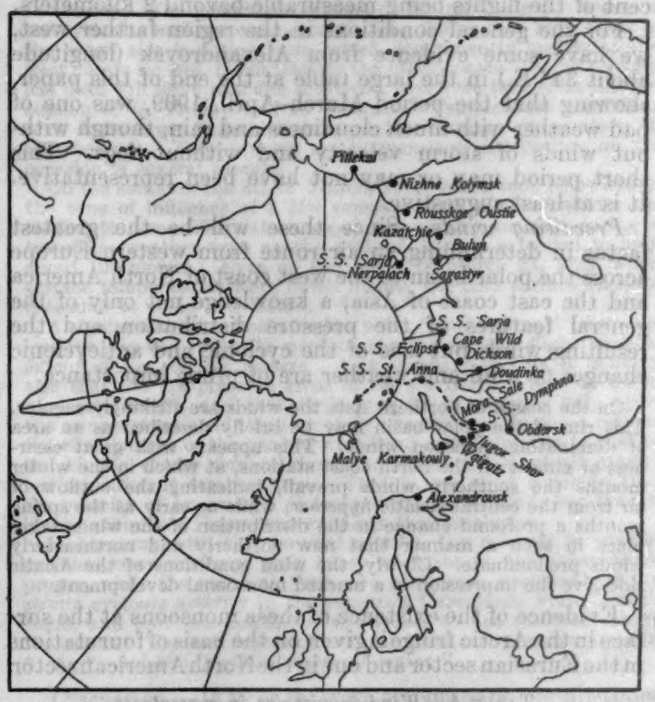

FIG. 1.—Stations represented by data in Table 8.

TABLE 2

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Franz Josef Land												
5.2	5.2	5.3	5.8	7.4	8.2	8.1	8.0	8.0	7.2	5.9	5.1	6.6
Spitzbergen												
6.4	6.3	6.1	6.6	7.3	7.8	8.0	7.9	7.8	7.8	6.9	6.1	7.3

So far as cloudiness is concerned, Franz Josef Land and Spitzbergen are dreariest in summer, with little to choose between them. In midwinter, however, while cloudiness at Franz Josef Land has declined to about 5, at Spitzbergen, nearer the open sea, it has decreased only to 6. These data are for cloudiness without respect to altitude of the clouds. At Dickson Harbor, in longitude

about 80° E. at the mouth of the Yenesei River, pilot-balloon ascents were made in 1917 between January 12 and August 31. They throw light on the frequency of cloudiness above certain altitudes at that point in the sector, as follows:

TABLE 3

		Jan.–Apr.	May–August
		Per cent	*Per cent*
No ascents on account of bad weather		14	42
Measurements of balloon	below 0.5 km	11	16
	between 0.5 and 2	25	24
	over 2 km	50	18

The most striking facts shown by Table 3 are (1) that during the period January–April flights were either omitted or reached but a half kilometer of measurable altitude only one-quarter of the time, and that they made better than 2 kilometers of measurable altitude half the time; and (2) that the May–August period was quite the worst on the score of bad weather and low clouds, only 18 per cent of the flights being measurable beyond 2 kilometers.

For the general conditions in the region farther west, we have some evidence from Alexandrovsk (longitude about 34° E.) in the large table at the end of this paper, showing that the period March–April, 1909, was one of bad weather with much cloudiness and rain, though without winds of storm velocity and without fogs. This short period may or may not have been representative. It is at least suggestive.

Prevailing winds.—Since these will be the greatest factor in determining an air route from western Europe across the polar basin to the west coast of North America and the east coast of Asia, a knowledge not only of the general features of the pressure distribution and the resulting winds but also of the cyclonic and anticyclonic changes of wind and weather are of prime importance.

On the coasts of northern Asia the winds are strikingly regular. This rim of the polar basin may be briefly described as an area of dominating monsoon winds. This appears with great clearness at almost all the north coast stations, at which in the winter months the southerly winds prevail, indicating the outflow of air from the central Asiatic *hyperbar*, while as early as the spring months a profound change in the distribution of the winds takes place in such a manner that now northerly and northeasterly winds predominate. Clearly, the wind conditions of the Asiatic side give the impression of a marked monsoonal development.

Evidence of the existence of these monsoons at the surface in the Arctic fringe is given on the basis of four stations in the Eurasian sector and one in the North American sector.

TABLE 4.—*Wind frequencies in percentages*

	N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calms
	Franz-Josef's Land								
Winter	11	14	21	7	1	1	4	12	29
Spring	6	8	20	12	3	3	7	9	32
Summer	8	6	13	12	4	4	12	8	23
Autumn	12	17	22	5	2	2	5	13	22
	Sagastyr (mouth of the Lena R.)								
Winter	1	3	8	19	23	19	13	6	8
Spring	3	7	23	18	10	9	16	8	6
Summer	7	13	30	17	5	6	11	10	1
Autumn	6	6	10	12	14	18	21	12	1

TABLE 4.—*Wind frequencies in percentages*—Continued

	N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calms
	Ustjansk (East Siberia)								
Winter	1	1	6	18	22	26	16	2	8
Summer	14	18	23	9	3	3	9	10	11
	Pitlekaj (Chukchi Peninsula)								
Winter	29	7	7	3	7	6	5	26	10
Summer	20	12	9	4	14	19	5	12	5

	Point Barrow (Alaska)									Average wind force (m. s.)	
										SW.–W.	*NE.–E.*
March	3	9	16	16	11	16	21	7	1	14	18
April	7	8	15	15	10	11	21	10	3	7	9
May	8	28	21	11	7	14	7	3	1	9	16
June	16	27	25	8	3	7	5	9	0	8	12

The vertical extent of the monsoons is important, but the only existing data on this point are not sufficient to form a basis for conclusions. They are the summary of pilot-balloon observations above Dickson Harbor, shown in Table 5. The monsoon is, of course, not evident, since the data cover both summer and winter months.

TABLE 5.—*Percentage distribution of high-altitude winds above Dickson Harbor (after P. Moltschanoff)*

Height (km.)	1	2	3	4	5
NE.	17	16	19	13	19
SE.	28	24	11	8	12
SW.	31	27	31	38	27
NW.	24	33	39	41	42
Number of cases	103	74	54	37	26

Cyclonic winds in the Arctic.—According to the *Fram* observations, the average *maximum* wind velocity in the polar basin proper was scarcely over 10 m./sec.; only very seldom were velocities over 15–18 m./sec. observed. In brief, the basin appears to be practically storm free.

Cyclones appear to be phenomena of the rim of the basin rather than of its interior, penetrating the basin but infrequently. What are the wind velocities in this border region?

For the sector which includes Spitzbergen, Franz Josef's Land, and Nova Zembla one may usually count on the region being overlaid with a low-pressure circulation. We have data (in the large table at the end of this paper) for Alexandrovsk and Maly Karmakuly showing for the earth's surface mean wind forces (Beaufort) ranging from 3.2 to 7.5, with calms at the latter station (on Nova Zembla, 33 years) ranging from 13 to 17 per cent of the time. With respect to the winds aloft, data are presented in Table 6 for maximum wind velocities up to 5,000 meters over Spitzbergen in the summer half (April–September) of the years 1912–1913. They show that the lowest maximum velocities occurred not at ground level but at some elevation less than 1,000 meters (12 m./s. at 500 m.)

TABLE 6.—*Maximum wind velocities over Spitzbergen, summer half, years 1912–13*

Altitude	0	500	1,000	1,500	2,000	3,000	4,000	5,000
Velocity (m./s.)	20	12	18	16	20	16	24	24

This point is of interest in connection with the question of the probable thickness of the polar cap of surface cold air, to be referred to later. In general, then, this sector of the rim does not appear to be excessively windy. This is in spite of the fact that, so far as they have been mapped, the traveling cyclones in this region have noticeably steep gradients. It is pointed out that allowance must be made for the great poleward increase in the deflective force of the earth's rotation and the consequent decrease of the gradient wind, as shown by Table 7.

TABLE 7.—*Gradient wind velocity in relation to pressure gradient and latitude. (Wind in m/s.)*

Pressure gradient	0.5	1.0	1.5	2.0	2.5	3.0
Latitude:						
10°	18.3	36.7	55.0			
20°	9.3	18.6	27.9	37.2	46.5	
30°	6.3	12.7	19.0	25.4	31.7	38.1
40°	5.0	9.9	14.9	19.8	24.8	29.7
50°	4.2	8.3	12.5	16.6	20.8	24.9
60°	3.6	7.3	10.9	14.6	18.2	21.9
70°	3.4	6.8	10.8	13.6	17.0	20.4
80°	3.3	6.5	9.8	13.0	16.6	19.5
90°	3.2	6.4	9.6	12.8	16.0	19.2

That is to say, in the Arctic strong pressure gradients produce only moderate winds. In the climatological observations of the German Spitzbergen Observatory [is found] an illustration of this in the fact that a pressure change is not always correlated with a great increase in wind velocity. In October, 1912, the monthly minimum pressure (737.7 mm.) was observed about 60 hours ahead of the monthly maximum (772.3 mm.). The surface wind in connection with this change amounted to 8 Beaufort (determined by the value 14–16 m/s), while the velocity at 4,000 meters altitude only rarely exceeded 20 m/s.

There is a distinct seasonal difference in the behavior of the cyclonic centers after they leave Europe on their eastward journey. In the colder season those remnants of cyclones which manage to get beyond Europe move mostly north of the Asiatic coast, from the region of Barent's Sea, proceeding thence slowly eastward to Bering's Strait, on account of the dominance of the Asiatic high pressure. They intensify the coastal southwest winds which are the winter monsoon flowing from this high pressure. The summer cyclones move mostly over the northern part of the continent (hence not over the polar basin proper) and serve to intensify the easterly and northerly winds which are the summer monsoon flowing from the relatively high pressure in the polar area toward the relatively low pressure over Asia.

At all seasons, from this polar storehouse of cold air, come the quasi-periodic southward thrusts of that air which, operating in conjunction with warm air streams from more southern latitudes, serve to energize existing cyclones or to produce new ones.

Weather charts for the polar region.—It is not practicable to reproduce here the five series of synoptic weather maps presented in the paper under consideration. These charts are based on the observations made during the international polar year 1882–83, and are of particular interest because it appears that of the many manuscript charts drawn on the basis of these observations only a very few have ever been published.[3] The five series are based on the North Atlantic charts referred to in the footnote, plus data from 21 high-latitude stations, including 6 polar stations all but one of which are north of 70°.

The polar cold cap.—Evidence is presented by the authors to show that in all probability the cap extends to no great height above sea level:

> Disregarding the thermal influence, atmospheric pressure must decrease * * * from the Horse Latitudes toward the pole. The cold due to radiation, however, causes a collecting of cold air in the lowest atmospheric strata within the polar region proper. The equatorward boundaries of these cold air masses at the earth's surface Bjerknes has called the polar front. * * * This polar front does not extend symetrically about the pole. In the transition months the center of gravity of the cold air cap lies somewhere between the North Pole and the North American Archipelago, corresponding to the larger land masses there present. We have here on a large scale the same features as those shown on a small scale by the weather situations over every Arctic Archipelago, such, for example, as those shown for Spitzbergen by Kurt Wegener. According to that view the island produces a local high-pressure area which overrules the effects of the general pressure distribution, and clearly reveals itself by causing its own characteristic weather conditions. The wind blows from the interior through the fjords to the sea. The general movement of the air along the coasts is anticyclonic; and corresponding to this, the surface movement of the ocean also is anticyclonic, which consequently maintains the west coasts ice free, in contrast to the other coasts. Some aerological data will serve to make this clear, which we take from the discussion of G. Rempp and A. Wagner, "Temperature conditions over Spitzbergen" (publications of the German observatory in Spitzbergen). They present the temperature distribution on the occasion of several ascents.
>
> On the ascent of the 8th of March, 1912, which took place within the zone of influence of a low pressure area, a cold stratum extended to some 200 meters above the earth's surface; during a transition weather type on the 15th of April it extended to only about 100 meters. Even on the ascent of March 23, 1923, when surface temperatures were much higher, the cold surface stratum extended to some 300 meters. * * *
>
> A similar condition holds for the polar "anticyclone." Aerological records will probably confirm the fact of the slight vertical extent of the cold-air masses. As a corollary to this, it is likely also that the low-pressure areas of the far north extend to but a moderate height, and that their progression depends only upon the temperature conditions on their two flanks. In these regions the effectiveness of the general west-wind drift is inferior to that of the kinetic energy derived from the juxtaposition of air masses having different temperatures. That is, we must conclude that the velocity of progression of cyclones in the Arctic is less than in lower latitudes. Experience confirms this conclusion.
>
> In harmony with this forward motion, the cold air in coastal cyclones over northern Asia must originate in the polar basin proper, while the warm air from the southwest, energized by the strong cyclonic activity in the region of Greenland, Franz Josef's Land, and northern Scandinavia, streams thence eastward along the coasts. The storehouse of cold for these low-pressure areas is * * * not the "Asiatic center of action."

Discussion.—It is of interest to compare the altitudes of the top of the cold stratum on various occasions, given in the above quotation, with the probable height at which occurs the minimum of wind velocity over Spitzbergen (Table 6). The figures point to the inference that this zone of minimum wind may correspond to that of transition from the polar cold cap (believed by the

[3] Charts for the 1st and 2d of February, 1883, after A. H. Hazen, are to be found in the Hann-Süring third edition of the Lehrbuch der Meteorologie; for March 8 and 9 as a supplement to the Observation of the Lady Franklin Bay Expedition, and for April 30 to May 3, 1883, in Edouard Vincent's On the march of barometric depressions of the Arctic polar region from the month of September 1882 to the month of August 1883. Academie Royale de Belgique, Classe des Sciences, Memoires, Deuxième Serie, III, Brussels, 1910. Vincent evidently drew daily charts for the whole of the international polar year, but published only those noted. The most complete published charting of the results of this year's observations are the "Synchronous weather charts of the North Atlantic and the adjacent continents for every day from August 1, 1882 to August 31, 1883, published under the authority of the Meteorological Council," London, 1886. These charts extend only to 70° north latitude, but are especially valuable on account of the ship observation from the North Atlantic.

authors to be very thin) to the overlying body of warmer air. Detailed knowledge of the conditions and changes in altitude of the zone are of considerable importance. If the assumption be correct that the polar cap averages but a very few hundreds of meters thick (and the aerological results cited leave little opportunity for doubt on that score), the question arises as to whether the southward displacement of such very thin slabs of cold air could function adequately in the energizing of cyclones in the manner described by the authors. There seems to be a difficulty in harmonizing this view with that recently expressed by Simpson to the effect that when displacements of polar air take place they appear to involve not only the whole thickness of the polar troposphere but part of the polar stratosphere as well.

If the reviewer's inference from the early part of the above quotation is correct, the idea expressed is that the Bjerknes polar front is the front *of the very thin layer of cold air* described. Now, the evidence in Table 6 points to the existence at the top of the cold layer, of a distinct boundary surface between this cold layer and the relatively warm layer above. That similar conditions exist north of northeast Asia also is shown by Doctor Sverdrup in the preceding paper in this issue of the MONTHLY WEATHER REVIEW. He points out that there is little possibility of an interchange of air between the lower cold layer and the upper "warm" one. It would appear, then, that the polar cold-surface stratum exercises a quite secondary function in the mechanism of polar cyclones and anticyclones. It may be regarded as a lubricant between the rough earth's surface (ice surface) and the air streams in these cyclones and anticyclones. Doubtless when an outbreak of polar air pushes the polar front into lower latitudes, the thin surface layer participates in the movement to some extent. But one finds it difficult to believe that its cold front is *the* cold front. The observed depth of polar air streams on the occasion of outbreaks of polar air in middle latitudes seems entirely against such a view.—*B. M. V.*

TABLE 8.—*Extract from observations on the north coast of Russia (L. L. Breitfuss)*

Stations	Month	Temperature			Wind										Days with—					Cloudiness	Precipitation (in mm.)
		Mean	Max.	Min.	Frequency (in per cent)										Storms	Fog	Precipitation	Clear weather	Cloudy weather		
					Velocity[1]	N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm							
Alexandrovsk, 1909[2]	March	−8.6	+1.8	−20.8	3.2	6	0	1	5	50	10	1	0	20	0	0	14	1	11	.....	13.4
	April	−6.0	+2.5	−19.8	4.2	2	9	13	7	39	2	11	4	3	0	0	20	5	15	.....	24.9
	May	+0.6	+8.8	−10.2	4.1	27	6	8	1	15	3	11	16	6	2	0	24	0	23	.....	23.0
	June	+4.9	+23.4	−0.6	4.6	26	8	9	6	10	4	4	22	1	0	0	21	1	24	.....	38.0
	July	+12.2	+26.9	+2.7	3.3	41	3	8	1	8	2	4	15	11	0	5	.....	0	14	.....	.....
Malye Karmakouly 1876–1909.	March	−15.1	+0.9	−36.1	7.5	5	5	20	25	12	9	4	3	17	8	.....	14	.....	.....	6.7	18.8
	April	−10.3	+5.7	−31.5	7.4	10	6	18	19	13	9	5	4	16	9	.....	12	.....	.....	7.3	8.2
	May	−4.4	+13.2	−23.5	5.8	15	6	12	15	11	8	9	11	13	4	.....	16	.....	.....	7.9	13.9
	June	+1.1	+16.1	−7.4	4.9	18	6	10	12	7	9	7	18	13	3	.....	16	.....	.....	8.2	17.0
	July	+6.4	+22.1	−0.6	6.2	12	6	16	16	7	8	8	12	15	5	.....	13	.....	.....	7.6	31.0
Waigatz 1914–1917	March	−20.0	−1.0	−37.0	Spring.	3	7	10	7	13	21	10	19	10	.....	1	.....	.....	.....	.....	.....
	April	−9.0	+3.0	−31.0											.....	6	.....	.....	.....	.....	.....
	May	−3.0	+4.0	−15.0											.....	8	.....	.....	.....	.....	.....
	June	+3.0	+10.0	−10.0	Summer.	7	26	13	5	5	12	10	10	12	.....	18	.....	.....	.....	.....	.....
	July	+7.0	+24.0	−3.0											.....	16	.....	.....	.....	.....	.....
Jugor Schar, 1914–1917	March	−21.0	0.0	−42.0	.....	9	12	7	28	24	5	5	4	6	.....	7	.....	.....	.....	.....	6
	April	−9.0	+3.0	−36.0	.....	5	13	6	27	34	5	2	4	4	.....	16	.....	.....	.....	.....	2
	May	−2.0	+6.0	−18.0	.....	8	11	8	15	17	17	14	8	2	.....	10	.....	.....	.....	.....	16
	June	+5.0	+22.0	−6.0	.....	14	8	7	12	18	14	6	13	8	.....	16	.....	.....	.....	.....	33
	July	+10.0	+26.0	−4.0	.....	24	17	5	4	15	6	2	20	7	.....	22	.....	.....	.....	.....	28
Mora Sale, 1914–1917	March	−22.0	0.0	−42.0	Spring.	2	4	7	14	8	28	21	12	4	.....	0	.....	.....	.....	.....	.....
	April	−10.0	+4.0	−33.0											.....	4	.....	.....	.....	.....	.....
	May	−2.0	+5.0	−17.0											.....	7	.....	.....	.....	.....	.....
	June	+5.0	+18.0	−2.0	Summer.	24	5	12	8	2	9	12	20	8	.....	17	.....	.....	.....	.....	.....
	July	+14.0	+26.0	−1.0											.....	8	.....	.....	.....	.....	.....
Obdorsk, 1891–1900	March	−16.7	+3.2	−47.4	4.4	9	14	5	7	14	13	9	5	24	4.7	0.3	7.0	4.6	10.2	6.1	9.5
	April	−9.9	+8.9	−33.2	4.8	8	19	5	4	13	12	12	7	20	4.4	0.7	5.7	4.3	11.6	6.3	6.7
	May	−1.0	+21.1	−25.7	5.2	10	21	7	5	9	11	16	9	12	3.9	0.8	7.8	2.8	16.6	7.4	18.6
	June	+7.7	+27.6	−5.6	6.3	12	21	7	5	7	9	15	14	10	6.3	0.5	7.5	1.6	14.5	7.5	35.4
	July	+14.2	+29.6	+0.7	5.0	12	22	9	5	10	11	10	10	11	3.3	0.9	9.8	2.3	14.1	7.1	49.3
Steamship Dymphna, 1883[3] (in southern Kara Sea).	March	−19.3	−4.5	−34.5	5.0	9	4	8	10	17	5	6	3	38	.....	3	26	.....	.....	5.5	.....
	April	−12.4	+1.7	−32.1	5.7	9	4	3	4	16	15	8	7	34	.....	2	16	.....	.....	5.6	.....
	May	−9.5	+3.0	−28.4	4.9	18	5	9	2	3	3	7	13	40	.....	7	22	.....	.....	7.5	.....
	June	−0.5	+3.2	−6.4	5.0	16	7	6	5	2	6	13	9	36	.....	7	18	.....	.....	7.4	.....
	July	+1.7	+4.9	−2.4	4.8	5	15	18	5	5	7	4	3	39	.....	24	18	.....	.....	8.3	.....
Steamship St. Anna, 1913 (between lat. 77°–79° N. and long. 71°–77° E.).	March	−22.6	−6.2	−39.0	.....	21	4	22	15	5	4	7	17	5	.....	.....	.....	.....	.....	.....	.....
	April	−8.6	+6.2	−25.0	.....	13	13	17	10	13	13	11	8	2	.....	.....	.....	.....	.....	.....	.....
	May	−3.0	+6.8	−13.7	.....	14	11	8	12	7	19	13	16	0	.....	.....	.....	.....	.....	.....	.....
	June	+3.0	+20.0	+1.2	.....	9	3	8	13	4	22	22	18	1	.....	.....	.....	.....	.....	.....	.....
	July	+3.4	+18.7	−1.2	.....	8	5	7	8	2	33	21	15	1	.....	.....	.....	.....	.....	.....	.....
Dickson, 1916–17	March	−27.2	−4.9	−41.0	.....	14	11	7	10	3	33	18	1	3	23	1	14	4	13	6.7	2.2
	April	−20.0	+0.1	−36.4	.....	20	15	33	1	0	13	9	3	6	9	8	10	7	15	6.4	6.9
	May	−4.6	+2.3	−13.1	.....	2	3	19	14	13	22	14	8	5	13	9	12	0	30	9.8	9.2
	June	+0.8	+6.2	−2.4	.....	3	14	29	8	2	9	16	11	8	0	22	13	0	29	9.7	18.8
	Muly	+6.2	+19.0	−1.7	.....	11	22	24	4	5	13	11	4	6	5	20	16	0	27	9.2	30.1
Dondinka, 1912–1914	March	−28.8	−4.6	−46.0	6.2	9	1	24	13	13	11	1	12	16	4	3	8	11	6	5.1	4.3
	April	−13.0	+0.2	−36.1	7.5	11	19	20	4	6	10	9	10	11	8	1	15	6	11	6.5	13.6
	May	−4.1	+2.2	−14.4	7.7	17	28	6	6	10	15	9	9	0	8	2	16	1	19	7.3	12.1
	June	+4.4	+17.5	−6.8	6.8	14	17	9	16	8	8	12	12	4	4	3	15	0	22	8.6	45.3
	July	+10.8	+18.9	+1.9	7.2	22	37	6	3	3	8	6	12	3	6	1	19	0	22	8.7	72.3

[1] Wind velocities in m/s.
[2] Precipitation refers to the year 1908.
[3] Observations of wind velocity, days with cloud and days with precipitation are from the steamship Varna, which at this same time was drifting in the Kara Sea.

TABLE 8.—*Extract from observations on the north coast of Russia (L. L. Breitfuss)*—Continued

Stations	Month	Temperature			Wind										Days with—					Cloudiness	Precipitation (in mm.)
					Frequency (in per cent)										Storms	Fog	Precipitation	Clear weather	Cloudy weather		
		Mean	Max.	Min.	Velocity	N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm							
Steamship Eclipse, 1915 (Taimyr Coast near Cape Wild, 78° 40′ N., 91° 25′ E.).	March	−29.7	−4.8	−45.1	2.4	1	9	6	9	5	23	6	1	40	-------	3	-------	11	3	3.7	-------
	April	−13.3	+1.8	−35.4	5.6	4	13	7	2	16	41	9	2	6	-------	4	-------	4	18	7.3	-------
	May	−7.0	+4.7	−15.0	5.5	9	7	12	7	10	21	10	12	12	-------	3	-------	0	21	8.0	-------
	June	+1.4	+10.2	−3.9	2.7	10	19	15	4	4	6	6	4	32	-------	14	-------	3	16	7.3	-------
	July	+2.8	+15.1	−3.0	2.8	15	29	2	2	4	8	13	8	10	-------	19	-------	6	14	6.4	-------
Steamship Sarja, 1901 (Taimyr coast, 76° 8′ N., 95° 8′ E.).	March	−22.8	−10.4	−40.9	4.8	2	3	16	13	9	26	7	1	23	-------	-------	-------	-------	-------	6.6	-------
	April	−23.1	−7.2	−39.1	5.2	3	5	9	3	2	13	18	17	30	-------	-------	-------	-------	-------	4.4	-------
	May	−8.8	+2.4	−29.6	7.0	1	6	16	10	17	17	16	3	14	-------	-------	-------	-------	-------	7.6	-------
	June	+0.4	+10.4	−8.2	7.1	7	10	7	10	20	18	22	4	2	-------	-------	-------	-------	-------	7.9	-------
	July	+2.8	+12.8	−1.7	6.4	5	4	13	11	7	19	27	9	5	-------	-------	-------	-------	-------	8.4	-------
Sagastyr, 1882–1884	March	−34.3	−18.6	−47.5	4.7	1	5	22	25	14	7	12	3	11	0	1	1	-------	-------	3.2	0.2
	April	−21.6	−4.3	−37.4	5.2	2	7	23	14	7	11	21	10	5	1	3	2	-------	-------	5.3	0.6
	May	−9.6	+3.3	−27.3	6.2	5	9	23	16	9	9	15	11	3	2	7	10	-------	-------	7.7	5.0
	June	+0.0	+12.5	−12.6	6.8	4	11	27	19	7	6	15	10	1	4	12	8	-------	-------	8.0	11.9
	July	+4.9	+12.1	−0.2	8.9	16	21	37	18	0	0	0	8	0	8	18	5	-------	-------	7.6	6.9
Bulun, 1914	March	−30.1	−12.4	−42.6	6.1	35	3	0	1	10	14	5	1	31	5	0	4	8	10	5.8	2.9
	April	−17.9	+3.0	−41.4	3.6	17	6	1	0	9	18	6	6	37	1	0	8	3	14	6.8	14.1
	May	−4.6	+7.5	−23.3	5.3	40	25	4	1	1	1	3	5	20	0	0	1	2	13	6.8	0.1
	June	+10.0	+26.4	−4.6	5.7	13	27	7	2	14	17	8	3	9	2	0	7	1	13	7.5	11.4
	July	+15.6	+26.9	+2.9	5.4	22	33	10	2	8	7	4	4	10	2	0	7	3	15	7.2	23.8
Kazatchie, 1901–1905	March	−26.5	−6.0	−46.8	2.7	1	0	8	21	13	12	15	6	24	0	0	8	13	3	3.7	3.1
	April	−17.9	−1.1	−39.2	3.5	7	11	14	5	5	8	17	4	19	1	2	8	7	9	5.0	4.2
	May	−5.0	+8.9	−28.5	3.9	9	9	20	15	6	4	13	15	9	0	4	8	5	12	6.3	8.3
	June	+7.1	+27.6	−6.8	4.8	9	7	25	11	4	3	10	18	3	2	6	12	4	14	6.9	25.8
	July	+10.4	+26.5	−0.8	5.2	13	12	18	9	5	5	11	23	4	3	4	15	3	15	7.4	29.0
Steamship Sarja, 1902 (Nerpalach Harbor, Siberia Island, 75° 22′ N., 137° 10′ E.).	March	−32.7	−24.6	−40.1	5.4	2	0	18	55	16	1	1	0	7	-------	-------	-------	-------	-------	3.4	-------
	April	−21.9	−11.8	−36.2	6.8	11	16	40	16	3	2	1	3	8	-------	-------	-------	-------	-------	5.9	-------
	May	−11.0	−0.9	−22.0	4.3	14	14	20	8	11	3	4	12	14	-------	-------	-------	-------	-------	6.7	-------
	June	+0.7	+4.4	−9.8	6.8	8	20	28	8	5	2	1	21	7	-------	-------	-------	-------	-------	8.4	-------
	July	+2.1	+7.8	−1.7	5.8	12	5	11	16	11	5	10	23	7	-------	-------	-------	-------	-------	8.6	-------
Rousskoe Oustie, 1895–1903.	March	−31.0	−14.1	−48.6	3.8	4	8	18	6	2	26	12	4	20	2	0	6	14	4	3.4	7.8
	April	−21.9	−3.0	−44.8	3.9	4	11	25	10	3	17	12	6	12	1	0	3	13	4	3.4	3.3
	May	−6.4	+6.2	−29.9	4.1	6	8	31	17	3	6	8	7	14	1	3	10	5	15	6.7	9.2
	June	+4.8	+29.6	−11.7	5.2	11	10	27	14	5	5	11	10	7	2	2	14	2	17	7.7	27.0
	July	+10.8	+28.5	−1.2	5.2	10	8	23	12	9	5	12	12	9	2	0	12	3	15	7.0	29.7
Nizhne Kolymsk, 1901–1905.	March	−27.1	−0.8	−48.6	2.4	6	6	12	29	6	11	7	5	18	1	0	8	10	4	4.0	4.7
	April	−15.4	+2.2	−38.0	3.2	9	9	12	27	6	6	8	8	15	1	0	8	10	7	4.6	6.1
	May	−2.0	+15.4	−31.3	3.2	16	9	10	21	7	9	8	8	12	1	1	6	6	7	5.4	6.3
	June	+10.1	+25.0	−0.8	3.4	15	9	10	25	9	7	8	12	5	1	1	6	5	6	5.3	17.5
	July	+12.1	+26.7	+0.4	3.1	20	8	10	19	7	9	9	12	6	0	1	12	4	10	6.1	34.3
Pitlekai, 1879	March	−21.6	−4.2	−39.8	----------	29	6	2	6	13	8	7	24	5	-------	-------	-------	-------	-------	5.1	-------
	April	−18.9	−4.6	−38.0	----------	37	6	2	2	5	8	6	28	6	-------	-------	-------	-------	-------	6.4	-------
	May	−6.8	+1.8	−26.8	----------	24	19	13	3	8	5	8	19	1	-------	-------	-------	-------	-------	8.5	-------
	June	−0.6	+6.8	−14.3	----------	29	7	2	2	14	20	3	16	7	-------	-------	-------	-------	-------	7.0	-------
	July	+2.7	+11.5	−1.0	----------	10	16	16	7	15	18	7	8	3	-------	-------	-------	-------	-------	7.5	-------

THE EFFECTS OF A LIGHTNING STROKE

N. ERNEST DORSEY

[National Research Council]

On the night of Sunday, September 13, a tulip tree (*Liriodendron tulipifera*) in the yard of All Saint's Chapel, Annapolis Junction, Md., was struck by lightning. It was examined the next morning. On the following day it was inspected very carefully and photographs were taken. Other photographs were taken and inspections were made from time to time, for the purpose of confirming or of extending the memoranda previously made. The case is of considerable interest, as the effects produced give quite clear evidence of the direction of the stroke, and show that it was delivered to very restricted areas at points not over about 8 feet from the ground.

Some rain had fallen earlier in the evening; it is not known positively whether it rained much after the stroke, but the appearance, the next morning, of the ground in the corner by the steps (G, fig. 1), and the fact that leaves and dirt were still adhering to the wall of the tower (fig. 6) indicate that it probably rained but little after the stroke.

The prominent objects in the neighborhood of the tree are shown in Figures 1 and 2. Excepting a one-story concrete building about 60 feet to the east, there is no other tree or other prominent object to the west, north, or east within 200 yards of those shown in Figure 1. On the south there are trees, but the nearest is 75 feet distant. The group shown in Figure 1 is essentially isolated. The ground is nearly level to the south, west, and north, and slopes gradually downward toward the east.

The tree which was struck is A; it was 47 feet high, and 6 inches from the ground it had a girth of 49 inches. It stands between a 56-foot tower (wood, stone foundation, no lightning rod) and three other trees of approximately its own height; of these, two are of the same kind as itself. The highest and most exposed tree in the yard is B; it was not damaged in the least. The stroke ignored both B and the tower, passed in a vertical plane between C and D, each about 47 feet tall, and finally struck A about 8 feet from the ground. The most distant splinters were found at K and L; they were small. Small splinters were on the roof of the chapel, one was sticking in the frame of the door. The only large section torn from the tree lay at E; it was 14 feet long, and was bent about as indicated (see also fig. 7). At F, was a splinter 11 feet long, and 0.5 by 1.5 inches in section. With the exception of a 4-foot splinter which was caught in the branches, and which will be

mentioned again, the other splinters thrown off were small. Circles indicate the overhang of the branches of C and D.

Figure 3 is a view looking up and slightly to the east of southeast. At 5 feet from the ground, the splintered portion of the trunk lay in the angle HAI (fig. 1), its vertex was 4 inches from the northwest surface of the tree. Notice that the blazed portion did not extend to the top of the trunk. It had a very definite upper limit, 27 feet from the ground. The entire appearance of the damage suggests that the center of violence lay somewhere between the upper and the lower arrow—that is, between 12 feet and 8 feet from the ground. The standing splinter to the left (upper arrow) was 12 feet long, and 6 feet from the ground it had an arc of 4 inches;

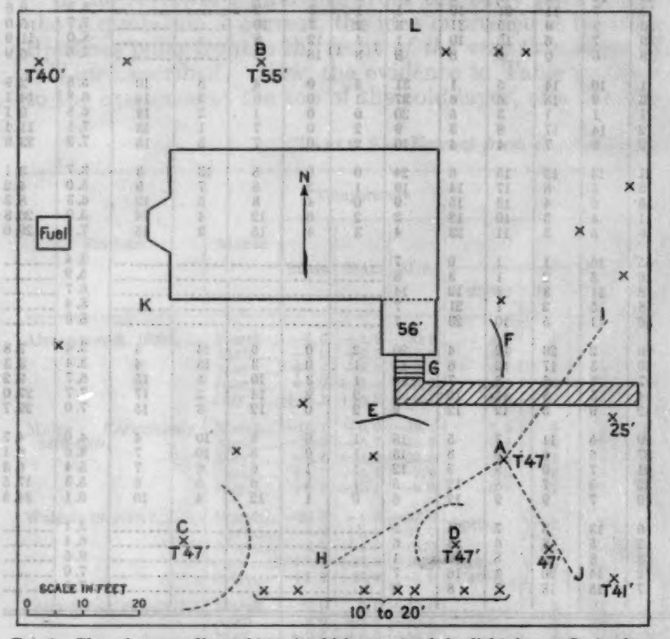

FIG. 1.—Plan of surroundings of tree A which was struck by lightning on September 13, 1925. Trees are denoted by crosses; tulip trees are marked with a T; numbers indicate height. Fuel shed is 6 feet high. Hatched area is a brick walk. Splintered segment lay in angle HAI, near ground the vertex was 4 inches below surface

sides of wedge[1] were 3.5 inches; some grass and dirt were on its upper end on Tuesday morning. At the level of the central arrow is a knot hole in the trunk, where a branch has been broken off and pulled out. On the upper side of the hole, a sliver from the branch still projected from the trunk; it can not be distinguished in the figure. At the lower arrow, notice a splinter which has been split and bent into the form of a T. This is a valuable reference object which will appear in other figures, and to which we shall have occasion to refer. We shall call it the "T splinter." The black, weathered ends of several stubs of branches, which had become inclosed by the trunk, may be seen.

Figure 4 is a view looking upwards and to the northwest; it shows the split in the unsplintered portion of the trunk. The split lay in the vertical plane through AJ (fig. 1). The extreme top of the split was near the top of the blaze, about on the level of the boy's head; he is 4 feet 8 inches tall. The lower 30 inches of the trunk was unsplit. The two sides had merely been bowed apart beyond the elastic limit of the wood. The blunt end of the cross of the T splinter is seen projecting across the top of the frame of the door; just below its end is seen the end of a small splinter which was caught in the frame of the door.

Figure 5 is a view looking slightly north of east. The rod leaning against the tree is 4 feet long. Note the large standing splinters; also the small ones which have been driven out from the interior and broken down, and which are now firmly clamped between two of the standing splinters. At the upper arrow is the top of the T splinter. At the lower arrow and in the interior, may be seen the upward pointing end of a reflexed sliver which is attached to the farther of the two upstanding splinters. This sliver was one inch wide, 0.5 inch thick, and 28 inches long, and was attached to the standing splinter at a point 54 inches from the ground.

At 5 feet from the ground, the standing splinter had an arc of 3 inches, sides of wedge were 3 inches. In order for the sliver to be able to fly clear of the standing trunk so as to be caught and bent into an angle of 30°, as shown, this splinter must have been blown out to a considerable distance from the vertical. If its deflection was such that it was bent into an arc of a circle tangent to the vertical at the ground, then the radius of that circle could not have been greater than 4 feet, and the chord joining the base of the splinter to the point of attachment of the sliver must have made with the vertical an angle of over 30°.

Along the edge of the unsplintered portion of the trunk, extending from the central arrow to the ground, there was a strip of bark 0.75 inch wide which had been frayed out as if whipped by the wind. It lay along a crack. From its lower end, and in the plane of the crack, there was a shallow furrow in the ground. The furrow was an inch in diameter and about 11 inches long. With the exception of two insolated frayed areas and four small punctures, this frayed strip was the only portion of the bark which was damaged except by a purely mechanical tearing. The four punctures will be described in a later paragraph.

One of the isolated areas of frayed bark was on the southwest side of the tree, not far from the frayed strip; it was 1 inch broad and 5 inches high; its lower end was 29 inches from the ground. The other was on the unsplintered segment of the trunk, in the plane of the split (AJ, fig. 1); it was 2 inches broad and 6 inches high; its lower edge was 3 inches from the ground. The trunk was not split under either of these areas, but the sapwood was discolored, and there was a central area which presented a porous appearance, but in which no hole nor crack was found, though a sharp probe was used.

In the plane of the split (AJ, fig. 1) and beginning 11 inches from the unsplintered side of the tree, there is a superficial hole in the ground; its opening was 1.5 inches in diameter; it was traced for a distance of 18 inches, and was nowhere more than 2.5 inches below the surface. Just beyond the brick walk, in the corner by the steps, about 15 feet from the tree, there was another hole about the same size and lying nearly in the same plane; it was even more superficial than the one on the other side of the tree; its opening was directed towards the tree. A little to the northeast of the hole first mentioned, and 6 inches from the trunk, there was a vertical hole 1 inch in diameter and 2 inches deep. It is believed that all three are burrows made by animals or insects; it may be the loose material initially hiding their entrances was sucked out by the electrostatic field attendant upon the dis-

[1] The cross-sections of all splinters have roughly the shape of truncated wedges, the bounding lines approximately coinciding with growth rings and radial lines. The dimensions are given in terms of the length of the outer arc and the average thickness along the two bounding radial lines.

(To face p. 480)

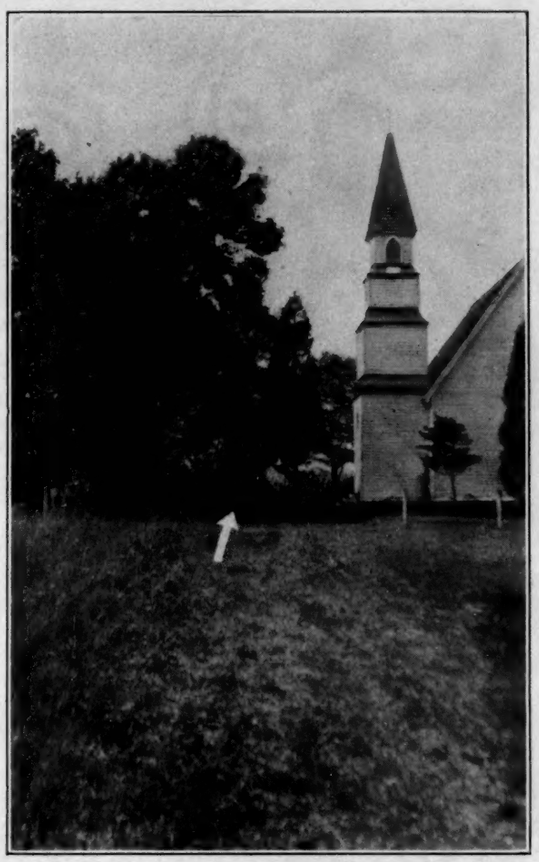

FIG. 2.—The arrow indicates the tree which was struck

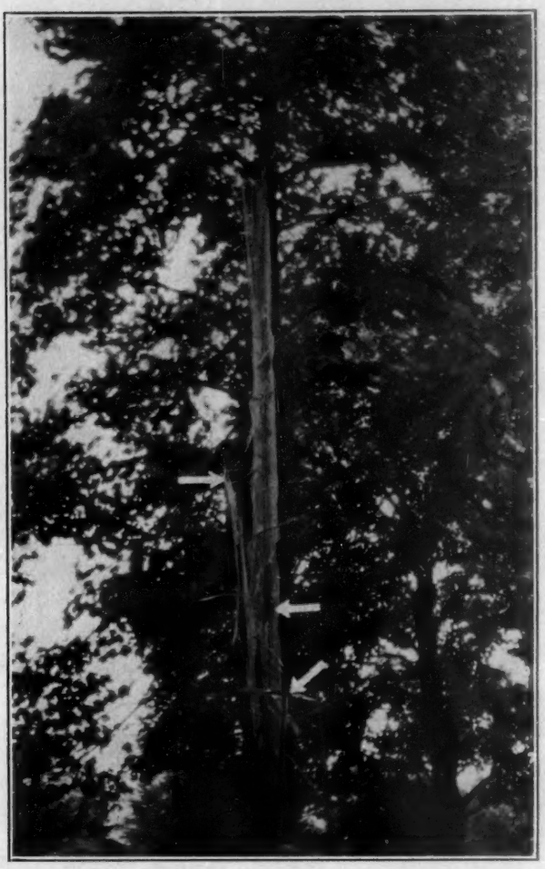

FIG. 3

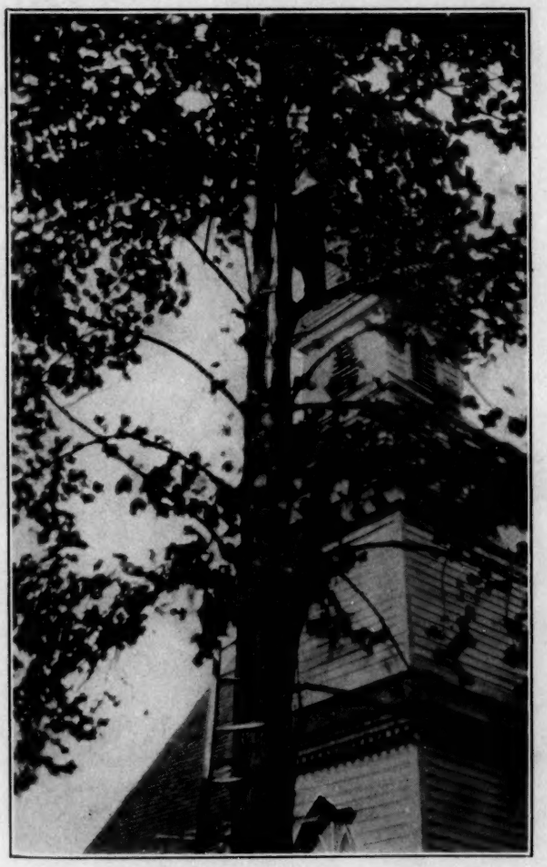

FIG. 4

FIG. 5

(To face p. 481)

FIG. 6

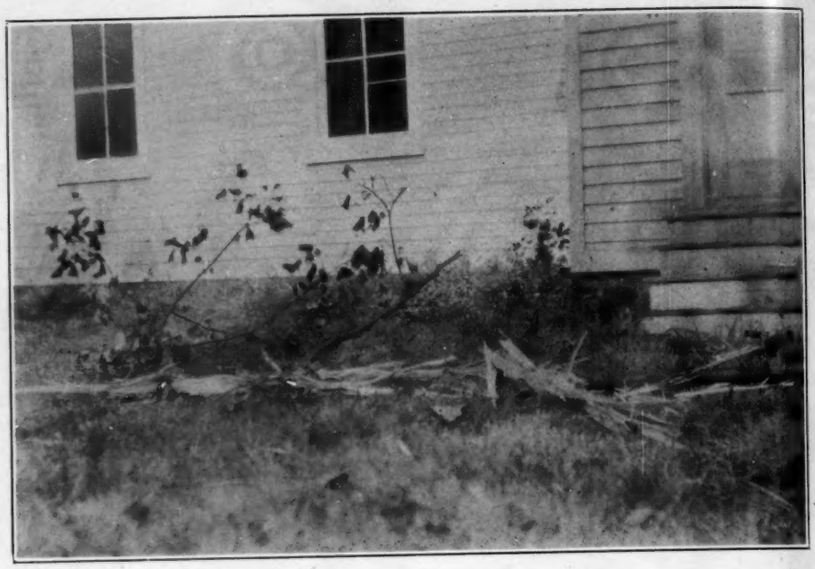

FIG. 7

FIG. 8

FIG. 9

charge, but it seems improbable that they are otherwise related to the stroke.

Figure 6 is interesting in showing how small leaves and dirt were spattered over the south side of the tower, to a height of 9 or 10 feet; none was on the east side. The ground in this corner, between the steps and the wall, gave no evidence of more than very superficial disturbance, but that disturbance was pronounced; the grass and débris had the appearance of having been combed upwards. The disturbed area was entirely within the rectangle (28 by 48 inches) between the steps and the wall (G, fig. 1). Only a few small splinters were found in this corner.

Figure 7 shows the only large section which was torn from the tree. It was bent approximately as shown at E (fig. 1), convex toward the bark; the lower end was to the east; the bend lay 20 feet from the tree. From the bend to the lower end was about 6 feet. This portion points about 30° to the right of the camera; the branch projecting from it and seen lying in front of the steps is the one which came from the knot hole at the central arrow of Figure 3; its junction with the section was about 3 feet from the bend. Neither end of this section dug into the ground; the condition of the ground and the appearance of the dirt adhering to the bend clearly indicated that the section struck upon the bend. The section must have been so bent before it left the tree.

Figure 8 shows the bend of the large section shown in Figure 7; the section has been readjusted so as to obtain a more suitable view; the upper end extends to the left. Notice how the fibers have been crumpled. An examination of the bend showed that the two portions of the section had been driven together, crumpling and crushing the fibers. As the section struck upon the bend, this damage must have occurred before the section left the tree.

Figure 9 shows the broken butt of the limb projecting from the lower portion of the section shown in Figure 7; here it is upside down. The limb itself may be seen below the section. Notice how squarely the butt has been broken; the fibers were not twisted nor split apart in the least. Where the break occurs, the fibers of the limb have become nearly parallel to those of the main trunk. This broken butt fitted into the knot hole at the central arrow of Figure 3. That hole was 10 feet 3 inches from the ground, and was nearly 1.5 inches deep. Furthermore, the sliver which still projected from the trunk fitted into the cavity at the left of the butt; this cavity was about 2 inches deep. The branch has been broken off squarely across the grain, and has been pulled out of the trunk as a tenon might be pulled from a mortise; in doing this, the sliver attached to the trunk has, reciprocally, been pulled from this section without damage to itself, although it was only 1 inch wide and near its tip was only 0.25 inch thick. Such a breaking and pulling apart could have resulted only from a tension which was quite closely along the direction of the fibers lying in the plane between the sliver and the butt; these made an angle of 33° with the vertical. What seems to have occurred is this: A force directed about 30° from the vertical was exerted upon the lower portion of the section (fig. 7) containing the limb; when the limb tore apart, this portion of the section drove into the upper portion, crumpling and crushing the fibers at the bend (fig. 8), prying off the upper 8-foot portion and driving the entire section upward and outward. This tore loose from the outer portion of the trunk a bark-covered splinter, 4 feet long, arc 5 inches, sides of wedge 3 inches, and threw it up into the branches, where it was still hanging on Monday morning, some 3 feet higher than the top of the blaze. This splinter carried the bark which was torn from just below the branch seen in Figure 3 at the left and near the extreme top of the blaze.

The top of the vertical portion of the T splinter (figs. 3 and 5) was 8 feet 3 inches from the ground. Through this splinter, just where it joined the top of the T, was a small hole, scarcely larger than a lead pencil, around which the wood was charred. Markings from a smaller hole were found 13 inches lower, where the right end of the cross of the T would meet the vertical portion, if the splinter were straightened out into its original position. At two other spots, 12 inches and 15 inches, respectively, below the latter, the bark was similarly charred. All four spots lay approximately in the same vertical line. These are the four punctures which were mentioned in the discussion of Figure 5. A careful search failed to disclose any other charred spots; special attention was given to the bend (fig. 8) and to neighboring portions of the trunk. At the lowest spot, merely the surface of the bark was charred; at the next, the bark seemed to have been penetrated, but there was no evidence that the wood under it was damaged. The hole appeared to make with the vertical an angle of about 28°. Marks matching the other two holes were found on the large, torn-out section and on two other (interior) standing splinters. It was thus possible to reconstruct, in part, this portion of the tree. From the region of the highest hole, too much material was missing, and what was available was too damaged by the bending and swaying of the splinter to permit one to draw any very definite conclusion regarding the initial nature of the hole, but it seemed to enter the tree almost horizontally. A large part of the material from around the second hole was available, and had been damaged but little. In particular, a fair length of the hole, including its very end, was found in a single large splinter. In sections normal to the length of the hole, the wood was discolored (grayish) over an elliptical area; 1 inch beyond the bark the vertical axis was 4 inches, the horizontal was 0.75 inch. The hole entered the wood at an angle of about 50° with the vertical. Its entrance was approximately three-eighths inch in diameter, and a very short distance after entering the trunk it was but little larger than the lead of an ordinary drawing pencil. It extended into the wood about 2 inches beyond the bark, and the vertical plane including it deviated but little from that marking the westernmost face (AH, fig. 1) of the unsplintered portion of the trunk; the deviation, if any, was probably to the north. The hole went straight through the sapwood without damaging it except by perforation. The same seemed to have been true of the upper hole, but there a strip of the trunk lying quite near the surface was shredded. Beyond this narrow strip, the wood appeared to have merely been slit apart, until the apex of the splintered portion was reached.

Along the apex, extending the entire length of the blaze and split, there was a column of fibers which had been quite completely shredded. Some idea of the nature of the shredding may be obtained from Figures 8 and 9. At a height of 10 feet, the shredded column was 0.75 inch in diameter. It lay quite closely along the grain of the tree. It was split, probably by a small knot (fig. 9), just below the square break; one segment was much larger than the other. The smaller segment passed to the west, and the larger to the east, of the squarely

broken limb; both followed the grain of the trunk, and thus united above the limb. It will be noticed that in passing around the limb to unite above it, the direction of the fibers has a very pronounced horizontal component, and where they reunite, they are nearly perpendicular to the direction of those composing the plane of slipping of the butt of the limb. (To see this more clearly, turn Figure 9 nearly upside down, so that the trunk is in its natural position.) The inner fibers actually formed a kind of inverted cup.

As the shredded strip extended to the top of the split, and possibly beyond it, it is natural to conclude that the tree was struck at a point still higher. But such was not the case. On the Tuesday after the tree was struck, the bark was examined very carefully, from the top of the split to the very highest crotch. It was entirely undamaged, except at one point. The point was 15 inches above the top of the split (hence about 18 feet below the top of the tree), on the unsplintered side of the tree, and on the upper side of a minor branch, close to where it joined the trunk. There, a piece of bark 0.25 inch wide and 1 inch long had been blown off, and at the trunk end of the stripped portion there was a hole about one-sixteenth inch in diameter, from which projected a small tuft of shredded fibers. Not only the presence of the fibers, but the appearance of the edges of the hole and the manner in which the bark was torn showed quite plainly that the damage was caused by a mechanical force acting from within outwards. After cutting off the branch, the hole was probed into the trunk to a distance of 3.5 inches, the probe being a No. 26 copper wire. Obviously the hole was almost completely clear for this depth, or it would have been impossible to have probed it with such a wire. Whatever produced it, blew it almost completely clear of woody material for a distance of about 4 inches.

After the tree had been thrown, it was sectioned. At the section 3 inches below the branch with the hole, the shredded column was evident as a spongy area; a part of it entered the knot corresponding to the branch. At the section 6 inches higher, the spongy area was much smaller; and at the top of the next 6-inch section, there was none to be seen. From that section there was but one branch, and neither it nor the bark of the section was damaged in any way. The top of the shredded column did not reach the surface, but ended in the interior of the trunk.

At the section made a few inches above the original ground level, the diameter of the shredded column was much less than it was at the level of the top of the T splinter.

There were five large, spreading roots (the tulip tree has no taproot). Of these, only one was damaged; of the five, there was but one which was smaller than this. The damaged root was 5.5 inches in diameter, and left the trunk in a nearly northwest direction. The apex of the damage was 0.75 inch from the south face of the root. The entire damage consisted in a rather minor splitting of this side. A small root (1 inch in diameter) from the same portion of the trunk was split on its lower side; the split was nearly radial, and not over one-fourth inch deep. This root lay entirely below the large ones. Here again the source of damage seemed to have been quite narrowly restricted to a small column of fibers; the split seemed to be merely a vent where the root gave way. There were incipient splits nearly coinciding with the growth ring passing through the column.

From these observations, it seems probable that, until it reaches the heart of the tree, the shredded column, marking the apex of the damage, is bounded throughout its length by the same sets of growth rings and radial planes, or by their counterparts in the roots and where knots disturb the regular arrangement. It seems that whatever produced the shredding had its origin near the level of the top of the T splinter, passed both upwards and downwards, with ever decreasing intensity, along a slender column of fibers, and experienced great difficulty in passing in a direction transverse to the fibers. Indeed, there was no clear evidence of any passage transverse to the fibers; in this direction, the trunk was merely splintered or split apart, or, as in the case of the hole in the small branch 15 inches above the split, the fibers are torn and punched out, but are not shredded.

Herein seems to lie the explanation of the square break. In its rush up the fibers, the shredding agent encountered the overhanging and somewhat cupped fibers above the branch, and was unable to penetrate them transversely with sufficient freedom to prevent the stresses from becoming greater than the tree could stand, even though most of the agent continued along the fibers, around the bend, and upwards.

What was the agent which produced this shredding? The orthodox answer seems to be: Steam, or other gases, liberated by the passage of an electric current through the tree. But to me this is not satisfactory; it seems to me improbable that steam or other gas could primarily have been responsible for all of the effects observed. I am of the opinion [2] that in this case the lightning stroke consisted of something analogous to an intense, high-speed beam of cathode rays, which planted in the trunk, at the depth of the shredded column, a large number of electrons. Their mutual repulsion, when their onward velocity was arrested, urged them in all directions; but having become attached to the molecules forming the contents and walls of the cells, they were unable to penetrate the fibers in a lateral direction, although they could travel with moderate freedom along the fibers, in the direction of the flow of the sap. Hence they traveled along the fibers, shredding them as they went; being unable to penetrate the fibers transversely, the tree was split, and the branch was broken squarely and pulled from the trunk.

Although many accounts of the effects produced by lightning have been written, their correlation is exceedingly difficult, owing to the omission of many important details. It is very desirable that there shall be placed on record in appropriate institutions a large number of detailed descriptions of such effects. In this country, the Weather Bureau seems to be the logical place for the assembling of such data. In the study of a tree which has been struck, the following details and types of observations seem desirable; others dictated by the particular case under study will occur to the observer.

1. A plan of the surroundings, drawn to scale, showing all prominent objects and the heights of those which are as tall or taller than the one struck, should be made. The kinds of trees and the types of buildings (whether frame, brick, with lightning rod, etc.) should be stated.

2. Both general and detailed photographs of everything that appears of probable significance or interest as affording information regarding the nature, extent, and location of the damage should be taken.

3. The ground, for a considerable distance in all directions from the tree, should be carefully examined, and notes should be made of all holes, furrows, and other disturbances which may have resulted from the stroke.

[2] For an elaboration of this opinion, see Journ. Washington Acad. Sciences, January, 1926.

Their sizes, locations, and directions are of importance. They should be entered upon the plan.

4. If the tree is splintered, notes should be made of the positions of the most distant splinters, as well as of all the large ones. The positions of the latter should be carefully determined; the distance, position with reference to the tree, and the position of the bark are of importance. Do they appear to have hit violently upon an end; if so, upon which; if not, is there any evidence of which part bore the brunt of the blow? (The main evidence is to be sought in the ground and in the soiling of the splinter.) All significant features, such as those which relate to the nature of the breaks, should be noted and photographed.

5. The nature of the splintering should be noted. Are all portions of the splintered material damaged in the same way, or is there indication of a path, or of paths, of peculiar damage? In the latter case, how do these paths differ from the rest, how are they situated, do they reach the surface at any point; if so, where, and how is the bark affected at that point? What are the sectional dimensions of the paths, and how do they vary from point to point? Trace the paths as far as possible; do they encounter any knots and; if so, how do they pass around them?

6. Search for punctures of the bark; remember that they may be very small. Are their borders scorched? Do they appear to have been made by a mechanical force acting from within outward, or the reverse, or is there no evidence bearing upon this point? The position of each puncture should be carefully noted, so so that it can be correlated with the other observations. If only a segment of the tree is splintered, an especially careful search for small punctures should be made in the neighborhood of each boundary of the splintered segment. In so far as possible, reconstruct the tree in the region of each puncture so as to determine the size of the hole, depth of penetration, the angle it makes with the vertical, and the plane in which it lies; the latter should be entered on the plan.

7. Note carefully the nature and the location of the damage to the bark and to the sapwood. Distinguish between a mere mechanical tearing of the bark as a result of the splintering of the tree and damages of other kinds.

8. If practical, throw the tree and note the location, extent, and nature of the damage to the roots, photographing everything of interest. Note carefully how the roots lie with reference to the ground plan. Section the tree at such points as seem desirable.

9. Nothing should be moved until everything of interest regarding its original position has been recorded. But after such records have been made, exhibits should be collected, carefully labeled, and preserved, at least until after a detailed report has been written.

10. Above all things, trust nothing to your memory; upon the spot, make written notes of all observations and of the impressions which they produce upon you. If practical to do so, move nothing until after you have written up and studied all the notes which you can otherwise obtain; you will frequently find that additional observations are desirable.

OCEAN TEMPERATURES AND SEASONAL RAINFALL IN SOUTHERN CALIFORNIA

A REVIEW OF THEIR RELATION BASED UPON RECORDS OF THE PAST NINE YEARS

By GEORGE F. MCEWEN, Physical Oceanographer

[The Scripps Institution of Oceanography, La Jolla, Calif., December 28, 1925]

The continuous record of seasonal rainfall at San Diego began in 1850, and may be regarded as typical of southern California in the variation from year to year. What is the likelihood of being able to predict the rainfall for a given year solely from a rainfall record? On examining the record for San Diego, which is the longest available in this region, there appears to be no definite relation of the rainfall during any season either to the rainfall of one year [1] or to that of any sequence of years preceeding it. For example, a rainfall above the average is just as likely to follow a dry year as a wet year. The distribution in time, of seasonal rainfall, appears to be as fortuitous as the result of coin tossing or drawing odd and even numbers from a pack of numbered cards.

Although it is impossible to predict what the next season's rainfall will be solely from the record of rainfall, it is possible to state the probability that it will be between any assigned limits. A suitable frequency curve, fitted to the 75 values of the seasonal rainfall at San Diego, yielded the results entered in Table 1.

TABLE 1.—*Frequency, in number of times per hundred that the rainfall at San Diego may be expected to have a value between the given limits*

Frequency	0.8	9.2	20.7	21.8	16.7	12.3	7.6
Limits	0-3.3	3.3-5.3	5.3-7.3	7.3-9.3	9.3-11.3	11.3-13.3	13.3-15.3
Frequency	4.1	3.0	1.5	1.0	0.5	0.3	0.2
Limits	15.3-17.3	17.3-19.3	19.3-21.3	23.3-25.3	25.3-27.3	27.3-29.3	29.3

[1] In the paper by L. E. Blochman, following, the reader will find a discussion, based on the San Diego rainfall record, which indicates a relation between San Diego summer rains and the rainfall of the ensuing season in southern California.—Ed.

From the frequency distribution of the rainfall, estimates can be made of the chances of having a drouth of given intensity (number of successive years when the rainfall is below a given amount) within any period, 50 or 100 years. For example, in an 11-year interval we may expect 8 or more years to have a rainfall less than 9.2 inches about once in a century.

About once in 50 years an 11-year period will contain 5 or more years during which the seasonal rainfall is less than 7.3 inches. The 11-year period from 1893 to 1904 corresponds to both of these cases. It contained 8 years during which the rainfall was less than 9.2 inches, and 5 years during which it was less than 7.3 inches. Computing the chances of a flood or drouth of given intensity is one kind of prediction, although no information regarding any particular year is thus obtained. Such predictions are of value to engineers in the economic design of storage systems for conserving the maximum amount of water.

Considerable work has been done in attempting to discover cycles or periodicities in various natural phenomena. The possibility of cycles in sun spots, temperature extremes, drouths, etc., and attempts to find correlations based upon such phenomena has aroused the interest of able investigators, as well as those less qualified to deal with such problems. In many cases the advocates of certain cycles have not been able to establish their claims. The problem of determining cycles empirically from observational data is in general elusive and difficult. Many people believe that the seasonal rainfall at San Diego is cyclical, and that the period is about 20 years. While periods of light and heavy rainfall do alternate in

general, the length of the corresponding time interval appears to vary too much from its average to justify applying the term cycle.

A simple rainfall sequence at San Diego, involving alternate intervals of 10 and 20 years was discovered by Mr. H. F. Alciatore, a fomer meteorologist of the San Diego Weather Bureau. The rainfall expressed in percentages of the average for the whole record is entered in Table 2 under the interval.

TABLE 2.—*Rainfall at San Diego, in per cent of the normal, during a sequence of intervals of 10 years, 20 years, 10 years, etc.*

1846–1855	1856–1875	1876–1885	1886–1905	1906–1915	1916–1935
108	90	122	90	109	92

The four middle intervals are complete, but the available record did not begin until the middle of the first interval, and has extended only to the middle of the last one. Beginning with 1846, the table indicates, consistently, that during alternate intervals of 10 and 20 years the average rainfall is alternately above and below the normal. This is the only rainfall sequence for San Diego that the writer has seen which holds consistently throughout the whole length of the record. It suggests the presence of a 30-year cycle. But values of the seasonal rainfall, above and below the normal, are irregularly distributed through both the intervals of high average and of low average rainfall.

Forecasts based entirely upon investigations of the rainfall record do not provide an estimate, in advance, of what the rainfall for the coming season will be. The conclusion is that specific forecasts of seasonal rainfall must involve the relation of rainfall to causes that can be observed and measured. Only as we approach to an understanding of the processes at work to produce rain, and as adequate observations are made and become available, can we expect to succeed in the difficult problem of forecasting. At present we are only near the beginning of such a huge undertaking that promises to involve not only investigations of the atmosphere and the sea, but the sun as well. The results of extensive investigation demonstrate the controlling influence of the oceans on the climate and weather of continental areas. An unusual amount of heat reaching any part of the ocean results in changes in atmospheric pressure and temperature gradients in the ocean. Thus changes in winds, ocean currents, evaporation, and precipitation arise. There is accordingly a continual interaction between the ocean and the atmosphere, as equilibrium is approached, but never reached. Moreover, it is now generally admitted that changes in the surface layer of the ocean can be observed months before the occurrence of their effect on the weather of a neighboring continent.

Since 1915 daily surface temperatures of the ocean have been observed at the end of the Scripps Institution Pier. An examination of the records indicated that the low rainfall during 1917–18 was preceded by summer ocean temperatures several degrees higher than the temperatures during the summer of 1916. In 1918 the summer temperatures did not return to normal. This suggested that a low seasonal rainfall for 1918–19 might be expected. (McEwen, 1918, p. 18; see bibliography.) The 1918–19 season proved to be even drier than the previous one. The inverse relation between summer ocean temperatures and the following seasonal rainfall indicated by these three years lead to the consideration of a possible temperature-rainfall relation as one of the institution's problems. It was also decided to publish experimental forecasts from the beginning, rather than to withhold the information until a long enough period of observations had been made to test adequately the validity of the relation.

The average seasonal rainfall at six representative stations has been used as an index of the rainfall over the coastal region of southern California. The following stations were selected on account of the length and continuity of their records, and their geographical distribution: Bonita, San Diego, Escondido, Tustin, Corona, and Los Angeles. The temperatures averaged for the interval from August 1 to October 15 were found, by trial, to give the most consistent results. The usual interval from July 1 to July 1 of the following year is used for the seasonal rainfall. These results to date are presented in Table 3.

TABLE 3.—*Summer ocean temperatures at La Jolla, and seasonal rainfall during the following year in southern California*

Year	Temperature	Departure from 9-year mean	Average of the seasonal rainfall at 6 stations	Departure of rainfall from 9-year mean
1916–17	66.4	−1.1	12.9	1.5
1917–18	68.8	1.3	10.9	−.5
1918–19	69.3	1.8	8.9	−2.5
1919–20	66.7	−.8	12.2	.8
1920–21	67.8	.3	10.8	−.6
1921–22	66.4	−1.1	21.7	10.3
1922–23	67.8	.3	9.0	−2.4
1923–24	69.5	2.0	8.7	−2.7
1924–25	65.5	−2.0	7.8	−3.6
1925–26	66.9	−.6		
9-year mean	67.5		11.4	

In eight out of the nine pairs of temperature and rainfall departures the signs are unlike, thus indicating a negative correlation between temperature and rainfall. From the average relation between temperature and rainfall departures shown by the table, the rainfall for 1925–26 was estimated to be 12.6 inches, or about an inch above the nine-year average.

The La Jolla temperatures have been used because of the length of the record. A program of daily temperature observations at other coast stations has been carried out since the La Jolla record began. These additional observations provide a means of obtaining some idea as to the size of the ocean area that behaves, approximately as a unit. The average ocean surface temperature at each of three southern California stations, La Jolla, Oceanside (30 miles north), and Hueneme (100 miles north) is presented in Table 4.

TABLE 4.—*Average ocean temperature at the surface during the period, August 1 to October 15 at each of three coast stations, La Jolla, Oceanside, and Hueneme, in southern California*

	La Jolla	Oceanside	Hueneme	Average of 3 stations
1916	66.4	[1] (64.8)	[1] (59.7)	63.6
1917	68.8	(67.2)	(62.1)	66.0
1918	69.3	(67.7)	(62.6)	66.5
1919	66.7	(65.1)	60.7	64.1
1920	67.8	(66.2)	61.0	65.0
1921	66.4	64.8	60.1	63.8
1922	67.8	67.0	60.8	65.2
1923	69.5	67.7	61.1	66.1
1924	65.5	63.5	58.1	62.4
1925	66.9	65.2	61.0	64.4
Mean	67.5	65.9	60.7	64.7

[1] Entries in parenthesis, ( ), have been estimated from the temperature at La Jolla from the average difference between the temperature at La Jolla and the other stations based upon the remaining observed values.

The consistent variation of temperature shown by Table 4 indicates that any one of the stations may be be used as an index of conditions over a large area. Since 1921, during a period of several months, from spring till autumn, frequent temperature observations have been made at two stations, one 5 miles west of the Scripps Institution Pier, and one 10 miles west. Weekly averages of these temperatures have varied consistently with those observed at the pier, thus affording additional evidence that pier temperatures are a reliable index of conditions throughout an extensive area. Evidence that temperature variations at inshore stations may be indicative of corresponding changes in a region extending hundreds or even thousands of miles away is afforded by observations from ships plying between San Francisco and Hawaii. Surface water temperatures taken from San Francisco about halfway to Hawaii were averaged by quadrangles 2° on a side or about 120 miles square for the period of 11 weeks from August 1 to October 15 in 1921 and 1922. About 300 temperatures were available for each period. The results are entered in Table 5, which shows that in 1922 the water was 1.5° F. warmer than in 1921. This difference is in agreement with Tables 3 and 4.

TABLE 5.—*Average surface temperature in two-degree quadrangles from San Francisco half way to Hawaii during the period, August 1 to October 15 in 1921 and 1922*

1921	58.5	61.2	64.4	65.1	65.0	68.0	66.7	70.5
1922	60.0	61.2	65.7	66.7	70.0	68.5	69.4	71.2
Diff.	−1.5	0.0	−1.3	−1.6	−5.0	−0.5	−2.7	−0.7

							Mean of all
1921	71.5	69.7	70.5	68.4	69.0	70.7	67.1
1922	72.0	70.3	71.1	71.2	70.0	73.0	68.6
Diff.	−0.5	−0.6	−0.6	−2.8	−1.0	−2.3	−1.5

The average temperature at La Jolla, Oceanside, and Hueneme (last column of Table 4) will now be considered in relation to the seasonal rainfall in each of several selected regions in southern California. Seven groups of rainfall stations having a sufficiently long record have been selected with reference to geographical differences. The stations making up these groups are listed below, each group being designated by a letter for reference.

A—Bonita, San Diego, Escondido, Tustin, Corona, and Los Angeles (low altitude and not far from the coast).

B—Crane Valley Reservoir, Huntington Lake, Kernville, Tule, and Yosemite (high altitude and farthest from the coast).

C—Azusa, Kaweah No. 1, Lytle Creek, Borel, Mill Creek No. 3, Santa Ana River No. 1, and Sierra (intermediate altitude and distance from the coast).

D—Lower Otay, Bonita, Escondido, El Cajon, San Diego, Barrett Dam, Diverting Dam, El Capitan, Morena Reservoir, and Cuyamaca (San Diego County stations ranging from a low altitude near the coast to a level of 5,000 feet).

E—Morena Reservoir and Cuyamaca (high altitude stations in San Diego County, about 75 miles from the coast).

F—Lower Otay, Bonita, Escondido, El Cajon, and San Diego (low altitude stations in San Diego County, the group farthest south).

G—Huntington Lake (highest altitude, farthest from the coast, and in the group farthest north).

A general idea of the location and area of the regions corresponding to these groups is presented by the map, Figure 1.

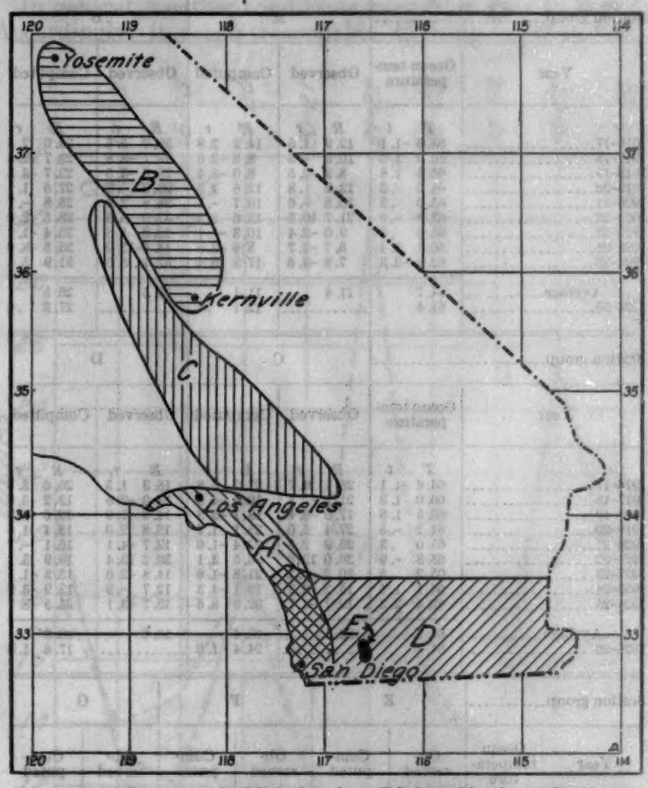

FIG. 1.—Rainfall areas used in this study. (Area F is formed by the overlapping parts of areas A and D ;area G, Huntington Lake, forms a part of area B.)

The relation of the seasonal rainfall, averaged for each group, to temperature, was found by fitting to the data the parabolic function

$$R = R_m + kt + lt^2 \qquad (1)$$

In this expression, R is the seasonal rainfall, R_m is the average of the values of R for the nine-year period, t = (temperature − 64.7), k and l are constant coefficients depending upon the way in which the rainfall varies with respect to temperature. The values of the constants R_m, k, and l are presented in Table 6.

TABLE 6.—*Tabulation of the values of the constants in the temperature-rainfall formula (1) grouped according to the regions* A, B, C, *etc.*

Group	K	L	R_m
A	−2.3	0.22	11.4
B	−2.2	.06	26.5
C	−3.3	.19	23.4
D	−3.2	.28	16.8
E	−4.0	.28	29.8
F	−2.7	.29	11.7
G	−1.4	.10	27.7

All of the data are assembled in Table 7, arranged according to years. The computed values of the rainfall, R result from substituting the temperature in formula (1).

TABLE 7.—*Seasonal rainfall R and departure r from the 9-year average for several groups of stations in southern California, observed and computed from ocean temperatures T.*

(See p. 485 for explanation of groups A, B, C, etc.)

Station group			A				B			
Year	Ocean temperature		Observed		Computed		Observed		Computed	
	T	t	R	r	R	r	R	r	R	r
1916–17	63.6	−1.1	12.9	1.5	14.2	2.8	32.0	5.5	20.0	2.5
1917–18	66.0	1.3	10.9	−.5	8.8	−2.6	22.7	−3.8	23.7	−2.8
1918–19	66.5	1.8	8.9	−2.5	8.0	−3.4	23.0	−3.5	22.7	−3.8
1919–20	64.2	−.5	12.2	.8	12.6	1.2	26.2	−.3	27.6	1.1
1920–21	65.0	.3	10.8	−.6	10.7	−.7	28.8	2.3	25.8	−.7
1921–22	63.8	−.9	21.7	10.3	13.6	2.2	32.0	5.5	28.5	2.0
1922–23	65.2	.5	9.0	−2.4	10.3	−1.1	28.3	1.8	25.4	−1.1
1923–24	66.1	1.4	8.7	−2.7	8.6	−2.8	13.6	−12.9	23.5	−3.0
1924–25	62.4	−2.3	7.8	−3.6	17.8	6.4	32.1	5.6	31.9	5.4
Average	64.7		11.4		11.4		28.5		26.5	
1925–26	64.4				12.1	.7			27.2	.6

Station group			C				D			
Year	Ocean temperature		Observed		Computed		Observed		Computed	
	T	t	R	r	R	r	R	r	R	r
1916–17	63.6	−1.1	28.1	4.7	27.2	3.8	18.3	1.5	20.6	3.8
1917–18	66.0	1.3	21.1	−2.3	19.4	−4.0	14.0	−2.8	13.2	−3.6
1918–19	66.5	1.8	17.0	−6.4	18.1	−5.3	14.9	−1.9	12.0	−4.8
1919–20	64.2	−.5	27.4	4.0	25.1	1.7	18.8	2.0	18.4	1.6
1920–21	65.0	.3	25.9	2.5	22.4	−1.0	12.7	−4.1	16.1	−.7
1921–22	63.8	−.9	36.0	12.6	26.5	3.1	30.2	13.4	19.9	3.1
1922–23	65.2	.5	20.2	−3.2	21.8	−1.6	14.8	−2.0	15.3	−1.5
1923–24	66.1	1.4	15.2	−8.2	19.1	−4.3	12.7	−.9	12.9	−3.9
1924–25	62.4	−2.3	19.7	−3.7	32.0	8.6	13.7	−3.1	25.5	8.7
Average	64.7		23.4		23.4		16.8		16.8	
1925–26	64.4				24.4	1.0			17.8	1.0

Station group			E				F				G			
Year	Ocean temperature		Observed		Computed		Observed		Computed		Observed		Computed	
	T	t	R	r	R	r	R	r	R	r	R	r	R	r
1916–17	63.6	−1.1	32.1	2.3	34.5	4.7	13.0	1.3	15.0	3.3	15.0	3.3		
											27.6	−.1	29.4	1.7
1917–18	66.0	1.3	24.0	−5.8	25.1	−4.7	9.9	−1.8	8.7	−3.0	23.5	−4.2	26.0	−1.7
1918–19	66.5	1.8	25.8	−4.0	23.5	−6.3	10.3	−1.4	7.8	−3.9	29.6	1.9	25.5	−2.2
1919–20	64.2	−.5	34.9	5.1	31.9	2.1	12.4	.7	13.1	1.4	28.0	−.3	28.4	.7
1920–21	65.0	.3	21.7	−8.1	28.6	−1.2	9.5	−2.2	10.9	−.8	31.0	3.3	27.3	−.4
1921–22	63.8	−.9	49.1	19.3	33.6	3.8	22.6	10.9	14.4	2.7	34.7	7.0	29.0	1.3
1922–23	65.2	.5	30.0	.2	27.9	−1.9	10.1	−1.6	10.4	−1.3	27.2	−.5	27.0	−.7
1923–24	66.1	1.4	23.3	−6.5	24.7	−5.1	8.8	−2.9	8.5	−3.2	14.5	−13.2	25.9	−1.8
1924–25	62.4	−2.3	27.4	−2.4	40.5	10.7	8.8	−2.9	19.4	7.7	33.2	5.5	31.4	3.7
Average	64.7		29.8		29.8		11.7		11.7		27.7		27.7	
1925–26	64.4				31.0	1.2			12.5	.8			28.1	0.4

A negative correlation between temperature and rainfall is indicated for each group, but there is only a rough numerical agreement between the computed and observed values. That is, but little significance can be attached to the numerical results of the computation. A comparison of the signs of the observed and computed departures indicates an agreement about 80 per cent of the time. The seasonal rainfall estimated for 1925–26 is entered in the last line. The same results are shown graphically by Figures 2 to 8, in which values of the rainfall are plotted as ordinates against years as abscissæ. The trend of the dashed lines (observed rainfall) agrees with that of the full lines (computed rainfall). The full lines are continued one year beyond the dashed lines in order to indicate the estimated rainfall for 1925–26. In Figure 9 the observed rainfalls for each of the independent groups *a*, *b*, *c*, and *e* are plotted as ordinates against the computed values, as abscissæ. The scattering of the plotted points about the full line gives some idea as to the agreement between computed and observed values, and accordingly the reliability of a forecast. Over 75 per cent of the points lie between the two dashed lines corresponding to errors equal to or less than 2 inches,

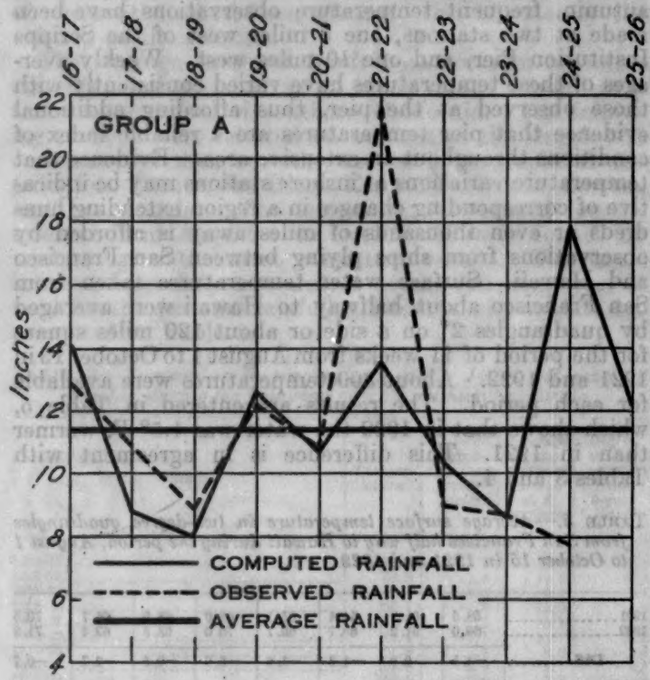

FIG. 2.—Predicted versus observed rainfall at low altitudes not far from the coast

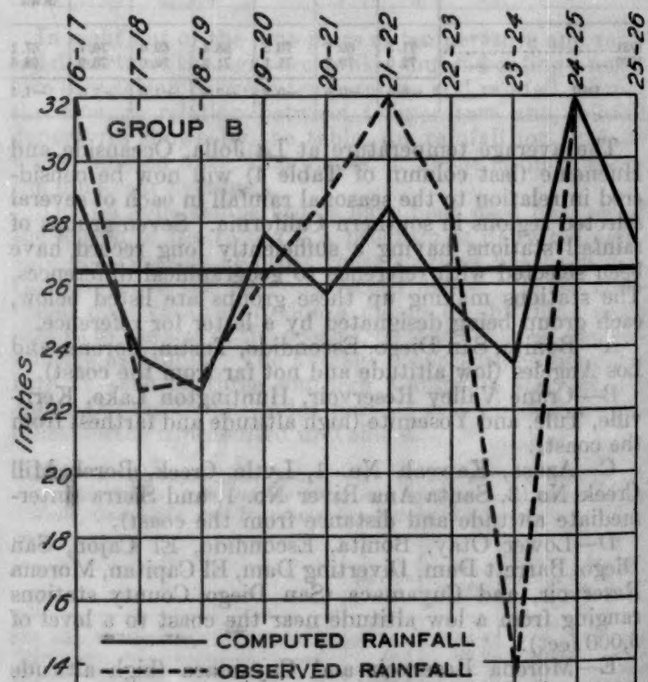

FIG. 3.—Predicted versus observed rainfall at high altitudes farthest from the coast

The question arises, will the relation indicated by the comparatively short series of observations continue to hold? Is the relation merely accidental or does it follow

from an actual physical relation between rainfall and a complex of factors of which the temperature of the ocean is a partial index? If a reasonable hypothesis can be developed which accounts for results already observed, it will support the presumption of an actual physical relationship, and consequent continuation of the indicated relation. The following hypothesis is offered as a preliminary attempt, subject to amplification and correction as more information becomes available.

Assume that atmospheric moisture is supplied by evaporation from the ocean into the overlying air. Assume that the rainfall in California results from conditions favorable for the precipitation of moisture in the air transferred from the ocean area over the land. Other things being equal, the greater the amount of air transferred from the ocean to the land the greater will be the amount of moisture available for precipitation on the land. There is abundant observational evidence of the existence over the North Pacific Ocean of an area of high pressure, which implies an excess mass of air. The monthly average intensity and area of this HIGH vary periodically from a maximum during late summer to a minimum during late winter. Also this seasonal variation in the atmosphere over the ocean is accompanied by an inverse variation over adjacent continental areas. Thus there is reason to expect a seasonal interchange of vast air masses between the ocean and continents, the transfer being toward the continent after late summer, resulting in the rainy season. However, this transfer is not a uniform or regular process. There is a continual disturbance of equilibrium, due partly to variations in land and ocean temperatures, which produces an irregular turbulent or pulsating movement, tending to restore equilibrium. Direct evidence of such a process is the succession of atmospheric disturbances called storms.

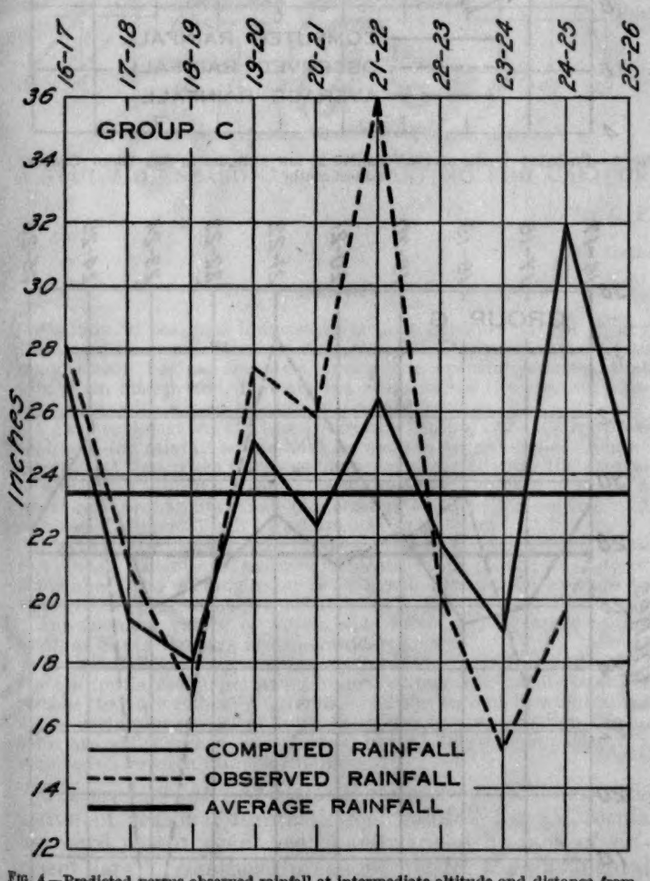

FIG. 4.—Predicted versus observed rainfall at intermediate altitude and distance from the coast

In general, weather conditions vary from year to year. Accordingly, it seems reasonable to suppose that the mass of air over the ocean in late summer that is available for transfer to the land during the following winter, or rainy season, varies from year to year. If, after a summer in which the barometric pressure is relatively high or the high pressure area is relatively large, a correspondingly large amount of air is transferred to the land, more moisture would be available for precipitation. Such a condition would be favorable for a wet year. Similarly, a relatively low barometric pressure or small area of high pressure would be followed by conditions less favorable for a supply of water vapor, sufficient to produce the usual amount of rain. According to this hypothesis any index of the extent of the area of high pressure or of the intensity of the "high" would serve to indicate whether the following seasonal rainfall would be light or heavy.

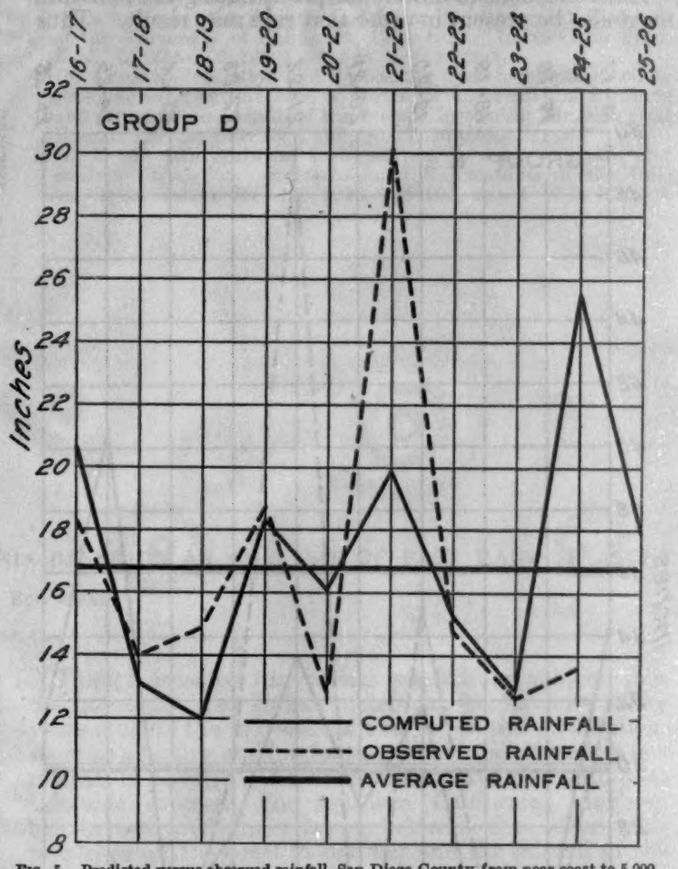

FIG. 5.—Predicted versus observed rainfall, San Diego County, from near coast to 5,000 foot altitude

There is a direct relation between the barometric gradient and wind velocity over the ocean, and there is convincing evidence (McEwen, 1912, 1914, 1916, and 1918) of an inverse relation between ocean temperatures and winds near the Pacific coast of North America. Accordingly, ocean surface temperatures near shore are an index of the condition of the oceanic "high." Moreover, the relation is an inverse one, low temperatures

correspond to steep barometric gradients, and high temperatures correspond to weak barometric gradients. Therefore the inverse relation found between late summer temperatures of the ocean near shore and the following seasonal rainfall would be expected. Thus ocean temperatures may be used to forecast the relative amount of moisture in the air available for precipitation.

But conditions favorable for precipitating the moisture must also be present in order that rain may result. Thus

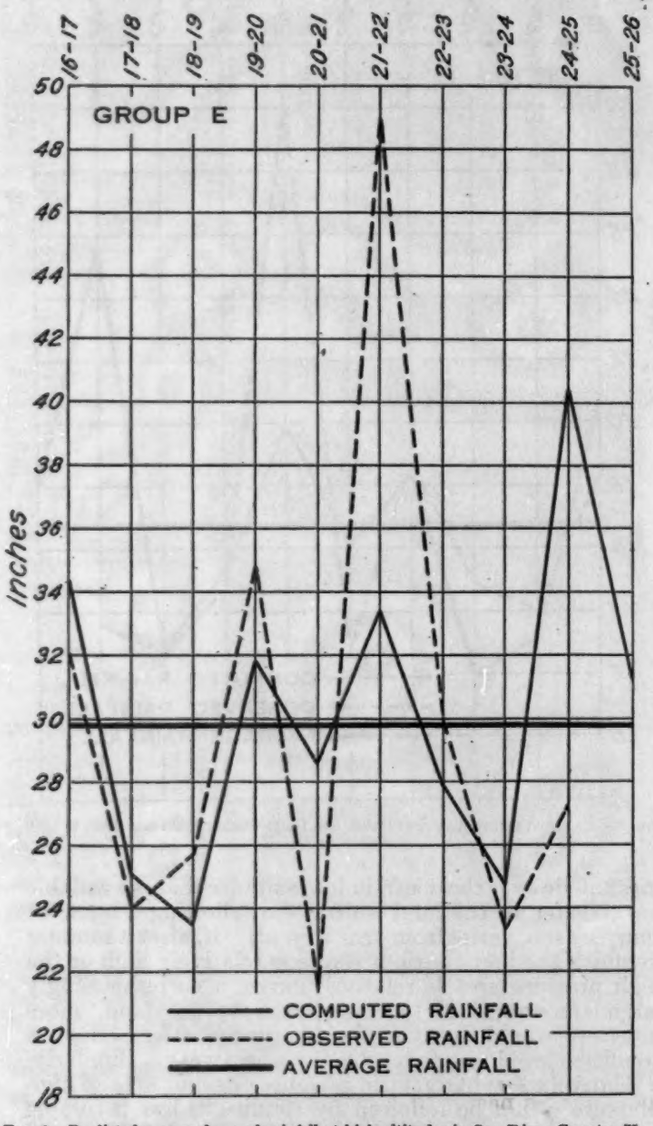

FIG. 6.—Predicted versus observed rainfall at high altitudes in San Diego County, 75 miles from the coast

forecasts of seasonal rainfall are essentially regional, and may fail at times for certain localities, because of an unforeseen lack of conditions necessary for precipitating the available moisture. In fact, an examination of the computed and observed departures of rainfall reveals, as would be expected from the hypothesis, that forecasts of deficient rainfall are more reliable than forecasts of rainfall above the average.

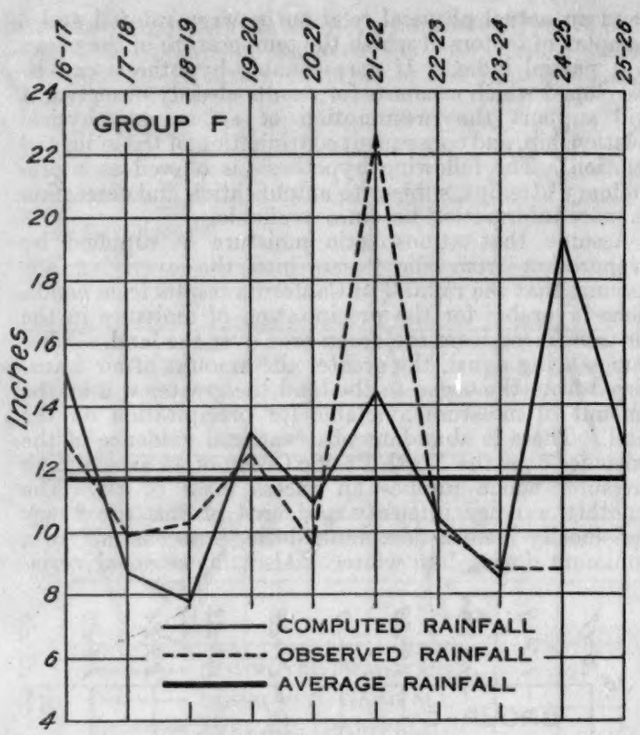

FIG. 7.—Predicted versus oberved rainfall at low altitudes in San Diego County, farthest south

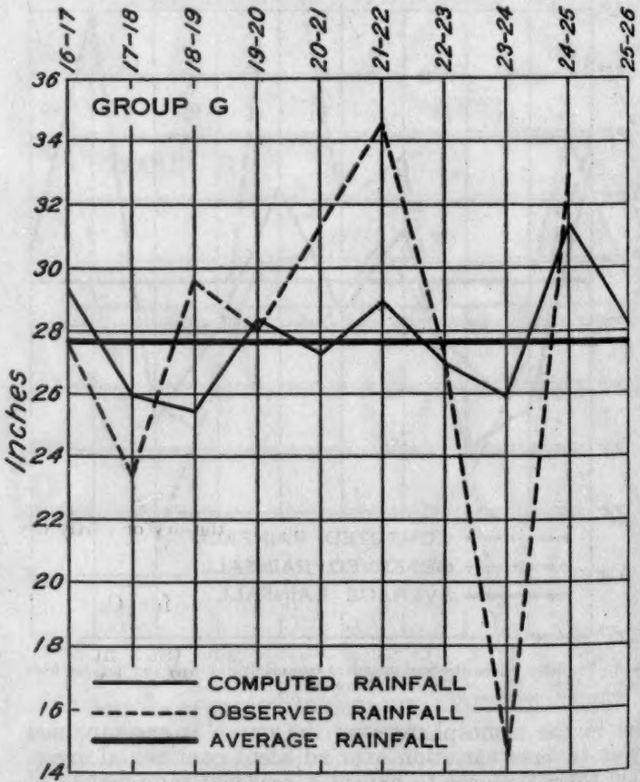

FIG. 8.—Predicted versus observed rainfall at Huntington Lake, highest altitude farthest from coast, and in group farthest north

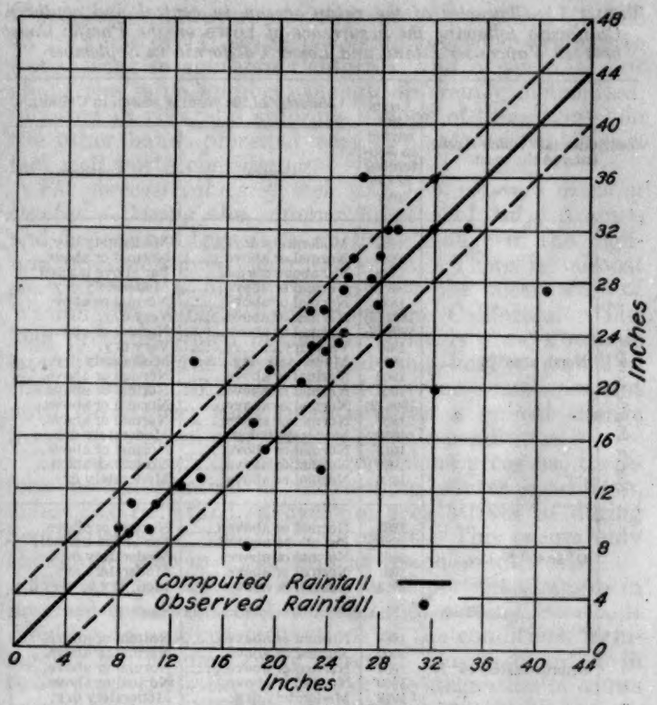

FIG. 9.—Relation of computed to observed rainfall, all groups

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A STUDY OF SEASONAL FORECASTING FOR CALIFORNIA BASED ON AN ANALYSIS OF PAST RAINY SEASONS

By L. E. BLOCHMAN

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SYNOPSIS

A study in seasonal forecasting is here outlined on the theory that conditions are forming over the Pacific Ocean before the rainy season begins, and also during the opening months, that will, when interpreted, indicate the character of the ensuing rainfall season with a high average of probability.

I have investigated the last 40 seasons (ending 1924–25) for pressure, and for rainfall as far back as records are available. I have ascertained that when low-pressure areas enter directly the central to southern California coast in September or October, there is a ten-to-one probability that the ensuing season (for central and southern California) will be an average to wet one.

I have also collected data to show that in the seasons in which San Diego has above average summer rains (July, August, or September) the ensuing rainy season will likewise be average to wet, with a 90 per cent probability.

The forecast values of appreciable rains in November as far south as Santa Barbara is also considered.

The rainfall for the same seasons in northern, central, and southern California are sometimes proportionately alike while in other seasons they are radically different. Of the seasons in which there are no early movements of LOWS or no summer rains at San Diego, some are still average to wet ones, but all the dry or partly dry seasons follow such rainless summers.

The present status of seasonal forecasting.—The investigation of seasonal forecasting of rainfall for California has until recent years been handicapped by lack of sufficient data. Weather Bureau records for the continental area are abundant, but it is only since 1922 that we have been able to form much idea of conditions over the Pacific through radio reports. Thanks to the success of the San Francisco office of the Weather Bureau in enlisting the cooperation of steamship companies, data from the oceanic area are now being received which will enable us gradually to improve the basis of our attempts at seasonal forecasting for California. This is a subject which, owing to its economic importance, is well worth all the attention any investigator can give to it.

Though seasonal forecasting is a baffling subject, it is not hopeless. The Indian meteorologists have for many years studied the movements and intensities of the monsoons as affecting and forecasting the rainfall of India a few months in advance, and their efforts have met with considerable success. For southern California, McEwen has investigated the relation between the water temperatures off the coast in summer and the rainfall of the following rainy season. His method has so far produced very encouraging results. But we are still in the pioneer stage of long-range forecasting, and conclusions must be accepted tentatively and held open to revision as data accumulates.

Three divisions of the State for rainfall.—This State is so generally considered as northern and southern California that meteorologists have fallen into the same habit. I believe, however, that it is much more accurate to divide it into three sections, northern, central, and southern. Even this demarcation is somewhat vague; however, as nearly as seemed practicable, I have drawn the lines of division as follows: A line from northern Marin County to the city of Marysville would divide the northern from the central section, and a line from the coast at Monterey across to Merced would mark the division between central and southern California. Our main discussion will relate to the central and southern California sections. The dry region everywhere east of the Sierra is climatically always in a separate class.

In referring to rainy seasons they are always understood on the Pacific coast to begin with July 1 and to end with June 30. East of the Rockies the season agrees with the calendar year. As to the kinds of rainy seasons, I divide them into four types and consider that any further division would be impracticable. It becomes

necessary also to extend the range of the rainfalls which shall be considered as average for the season, and which should be limited on the one hand by rainier seasons and on the other by the drier. Expressed in percentages of the normal seasonal rainfall they are as follows:

WET seasons range upward from 120 per cent of normal.

AVERAGE seasons range from 80 to 120 per cent of normal.

MODERATELY DRY seasons range from 60 to 80 per cent of normal.

VERY DRY seasons range from 60 per cent of normal down.

Although the Weather Bureau classifies the depressions which enter the United States as North Pacific LOWS and South Pacific LOWS according to whether they come on shore north or south of latitude 40°, I have, for the purpose of this study, considered 43° as the dividing line, because the entrance of September LOWS north or south of this line seems so clearly related to the character of the ensuing rainy season in central and southern California.

The forecast value of September LOWS.—In some seasons in California rains begin in September; and while the September rainfall for central California averages only about 0.25 inch, in certain seasons it is much heavier. From the point of view of forecasting, however, it makes no difference as to the amount of the rainfall—its *source* is the factor for consideration. Prof. A. J. Henry has pointed out[1] that "Our precipitation in California is great or small according as to whether areas of low pressure enter the continent and move eastward in low or high latitudes."

It has been a moot question in California whether heavy September rains, being premature, were not indicative of an unfavorable ensuing rainy season. I therefore made a chart of the exact location where all of the September (and also October) LOWS entered the coast. I found very definite relationships between the point of entrance of the LOWS lower or higher on the coast, and the character of the ensuing rainfall season. It was not a casual matter, for instance, when a depression centered directly off the southern California coast. It meant that the HIGHS were not so intense as at the opening of other seasons or else that they were further back over the ocean. This allowed the LOWS not only to dominate the situation, but it seemed to be indicative of a condition for the coming season, namely an increased rainfall, or at least an average rainfall.

The approximate points of entrance of September LOWS since 1883 onto the Coast is shown in Table 1 together with the character of the subsequent rainfall season for central and southern California.

I summarize my investigation of September LOWS as follows:

1. Lows entering north of latitude 43° were followed by any of the several types of seasons, *but they preceded all the drier seasons.*

2. Lows entering south of latitude 43° were almost never followed by the very dry seasons; a very few were of the moderately dry type. September LOWS entering south of Cape Mendocino were almost invariably followed in southern California by normal or wet seasons.

[1] Henry, A. J., Seasonal forecasting of precipitation on the Pacific Coast, Mo. Wea. Rev., April 1921, p. 214.

TABLE 1.—*Character of the rainy season in central and southern California following the occurrence of* LOWS *on the Pacific Coast between Vancouver Island and Lower California in September*

	Latitudes at which LOWS entered the coast	LOWS occurred in September of the year	Character of the ensuing season in California: Central	Character of the ensuing season in California: Southern
North Pacific LOWS [2]	North of 45° N.	1884	Moderately dry.	Moderately dry.
		1885	Normal or above.	Normal or above.
		1889	Far above normal.	Far above normal.
		1891 (2)	Normal or above.	Moderately dry.
		1892	Normal or above.	Normal or above.
		1893 (2)	Normal or above.	Very dry.
		1894 (2)	Normal or above.	Normal or above.
		1897	Very dry.	Very dry.
		1899	Moderately dry.	Moderately dry.
		1902	Normal or above.	Normal or above.
		1904	Normal or above.	Normal or above.
		1905 (2)	Normal or above.	Normal or above.
		1907	Normal or above.	Normal or above.
		1912	Moderately dry.	Moderately dry.
		1913	Normal or above.	Normal or above.
		1914	Normal or above.	Normal or above.
		1920	Normal or above.	Moderately dry.
	41° to 45° N.	1883	Normal or above.	Normal or above.
		1889	Far above normal.	Far above normal.
		1895	Normal or above.	Moderately dry.
		1901	Normal or above.	Moderately dry.
		1903	Normal or above.	Mod. dry to very dry.
South Pacific LOWS [3]	Approximately 39° N.	1888	Normal or above.	Normal or above.
		1902	Normal or above.	Normal or above.
		1904	Normal or above.	Normal or above.
		1909	Normal or above.	Normal or above.
		[1] 1919	Moderately dry.	Moderately dry.
	Approximately 37° N.	1908	Normal or above.	Normal or above.
		1916	Moderately dry.	Normal or above.
	Approximately 35° N.	1887	Moderately dry.	Normal or above.
		[1] 1898	Moderately dry.	Very dry.
		1910	Normal or above.	Normal or above.
	Approximately 33° N.	1900	Normal or above.	Normal or above.
		[2] 1911	Very dry.	Normal to mod. dry.
		1918	Normal or above.	Normal to very dry.
		1921	Normal or above.	Normal or above.

[1] Westward extension of an interior LOW.
[2] Sonora type storm.
[3] U. S. Weather Bureau classification.

3. Two LOWS in the table show a westward spreading or extension in September, and were followed by the moderately dry type of season. The westerly extension of LOWS at this time of year is evidently not favorable to precipitation in central and southern California.

In September the North Pacific LOWS predominate, some of them entering well to the north of the area included in the United States Weather Bureau weather map, coming into the United States east of the Rockies in the usual course. But it must be borne in mind that September is still a summer-type month in California and few South Pacific LOWS are to be expected. There are only 14 seasons out of the past 40 years that have LOWS entering south of latitude 43° in September. They are: 1883, 1887, 1888, 1889, 1900, 1901, 1902, 1903, 1904, 1908, 1909, 1910, 1916, 1921. Of the LOWS 4 entered between Cape Blanco and Cape Mendicino. Two of them, those of 1883 and 1889, preceded very wet seasons; the one in 1903 preceded a full average season centrally, but the season was partly dry in the south. This last one is the only season out of the 14 that was dry for southern California. The rest of the seasons preceded by LOWS entering south of Cape Mendocino were all average to wet in southern California.

Considering, however, all LOWS entering south of latitude 43°, 12 out of 14, or 86 per cent, preceded average to wet seasons in southern California, and of such seasons about the same number, though differently distributed, followed in central California. None of these LOWS, on the other hand, preceded very dry seasons, which is a fact well worth considering.

The forecast values of high and low pressure areas of October.—During the summer months of July, August, and September there is very little change in the high-pressure conditions along the coast. There is, almost continuously, a high pressure over the ocean west of Washington, Oregon, and northern California. The high pressure, which in summer is nearly always oceanic later is both the oceanic and the land type. The change begins to come in October, or sometimes not until November; then there is often a radical change from the uniform and rainless oceanic conditions.

The steadiness of summer conditions gives us, therefore, no information of the coming winter conditions, unless, as remarked, a cyclonic area strikes in during September along the southern coast. This occurs only about one year in three, and at irregular intervals.

But as October is a month of important changes in pressure conditions and is sometimes a rainy month, it should give us some intimations of the conditions forming for the ensuing rainy season. This is manifest in two ways: (1) By the mobility or the stagnation of HIGHS over the plateau and the adjacent ocean; (2) by the occurrence of South Pacific LOWS in October.

(1) *The mobility or stagnation of the HIGHS.*—Early in certain seasons there is an accumulation of anticyclonic and therefore dry atmosphere in our central and southern California latitudes, extending well westward over the ocean and eastward to the Rockies. This area of high barometer sometimes remains stagnant over the plateau for a considerable period. If the stagnation increases in November, there is a season of below-the-average rainfall in the making. But if the HIGHS move rapidly across, this indicates that there is no stagnation forming west of the Rockies to prevent storms coming in from the ocean.

Normally in winter, plateau HIGHS move on southward and southeastward. They thus admit of the entrance of the LOWS, which correspondingly become deflected more to the south. But in certain seasons this high pressure does not move normally southward, but remains centered in the plateau region. For some as yet unknown cause in some winters a descending cold dry atmosphere seems to come down directly over the plateau, or over the ocean, or over both areas, and intensifies this already anticyclonic condition.

Sometimes a North Pacific LOW will be deflected southward and begin to disrupt this stagnant Great Basin HIGH, or the oceanic HIGH, but with only temporary success. Not until the HIGH decreases in its own intensity, i. e., not until the barometer falls appreciably in the plateau itself, can any LOW impinge permanently and give rain anywhere near by. Though this continental HIGH may begin in October, the peak in dry seasons is not reached until the end of December and sometimes even in January. The less it is disrupted during this period the more pronounced will be the dry season, especially in southern California.

(2) *The South Pacific* LOWS.—Of an opposite condition to both oceanic and continental HIGHS are the welcome October LOWS.

September on this coast, as previously remarked, is barometrically a month of the summer type. When occasionally a rain does fall, it is only for a day or two, after which the normal summer type of weather returns and continues. October is different, but its character varies considerably in different seasons. It may show a continuation of the average September summer type, it may be of the rainier type, or it may partake of both types. Barometrically it is also different from September. Even if no rain falls, the high pressure over the ocean is changing its position, especially in certain seasons.

I have investigated all the October LOWS for 40 years, up to and including the season of 1921–22. This period has 15 seasons with South Pacific October LOWS, 38 per cent of the whole. Occurrences of both September and October LOWS in the same season are certain to be followed by an average to wet season in *either* central or southern California, without a single exception. There is also a strikingly high percentage of these seasons that are quite wet in *both* central and southern California. It is almost a certainty (better than a 90 per cent probability) that when South Pacific LOWS enter south of Cape Mendocino in either September or October, the ensuing season, especially for southern California, will be average to wet. This high percentage does not hold good for northern California, but it does for central California.

The 15 seasons referred to as having October South Pacific LOWS are: 1883–84, 1889–90, 1890–91, 1894–95, 1896–97, 1900–1901, 1902–3, 1904–5, 1906–7, 1908–9, 1909–10, 1910–11, 1916–7, 1921–22, and the slightly below-average season of 1901–2, which was below average only in southern California. In some instances LOWS are not shown on the maps, but they are inferable from the text; especially does this apply to the so-called secondary LOWS. After reviewing the daily weather charts, I have proceeded on the assumption that when a heavy rain comes in from off the coast and the influence of the primary LOW is not apparent, this rain is caused by a secondary LOW.

The significance of November rains in the South.—When, as far south as Santa Barbara, the average or nearly the average rainfall in November occurs, it appears to be indicative of the free movement of LOWS, and, except in a very few instances, average to wet seasons follow.

The average November rainfall at Santa Barbara is 1.50 inches and the average seasonal rainfall 18.50 inches. We may consider an inch as a fair precipitation for November, and note the kind of season ensuing, with 1 inch and upward of November rains. I have listed every season since 1867, and find there are 23 seasons at Santa Barbara having an inch or more of precipitation in November. These 23 seasons I have tabulated as follows (see Table 2): The first column contains the seasons since 1867 having a rainfall at Santa Barbara for November of 1 inch or more; the second column gives the rainfall at Santa Barbara for the corresponding Novembers; the third column gives the totals of the respective ensuing seasonal rainfall; the fourth column gives in percentage of the average rainfall the corresponding seasonal rainfall for southern California. and the fifth column the same information for Central California.

TABLE 2.—*Relation between November rainfall of 1 inch or more at Santa Barbara and the rainfall of the ensuing season, at Santa Barbara and in southern California*

Season	Santa Barbara November rainfall (inches)	Santa Barbara seasonal rainfall (inches)	Percentage of average seasonal rainfall	
			Southern California [1]	Central California [2]
1867–68	2.30	25.22	150	167
1868–69	1.25	15.77	100	91
1871–72	1.80	15.00	[3] 73	120
1874–75	1.30	18.70	85	82
1875–76	6.53	23.07	125	125
1877–78	1.32	29.51	137	125
1879–80	1.62	25.64	133	120
1885–86	9.84	24.24	145	140
1887–88	1.10	21.71	105	68
1888–89	5.62	21.58	120	100
1889–90	3.20	32.43	175	185
1892–93	4.27	26.97	130	112
1896–97	3.50	18.50	115	98
1899–1900	1.97	12.66	58	106
1900–1901	4.00	15.40	98	107
1901–2	1.16	14.21	72	90
1902–3	4.00	20.74	120	98
1905–6	1.14	22.70	126	128
1908–9	1.84	36.29	124	116
1909–10	2.34	19.62	92	86
1913–14	3.40	31.50	140	130
1918–19	3.64	14.50	80	102
1922–23	1.98	17.00	70	100

[1] These percentages are based on the averages at the following stations: Santa Barbara, Los Angeles, San Bernardino, Santa Monica, Riverside, Redlands, and San Diego, the percentages for the earlier years being based on the fewer stations then available.

[2] These percentages are based on the averages at the following stations: San Francisco, Sacramento, Marysville, and Merced, the percentages prior to 1871–72 being based on San Francisco and Sacramento only.

[3] 1871–72 was a wet season north of Santa Barbara; San Luis Obispo had 27 inches, San Francisco 31 inches. We have but scant records from south of Santa Barbara for these early years. Los Angeles unofficial records give 12 inches, or 78 per cent of normal, but as a whole southern California averaged 73 per cent only.

Reviewing this period of 55 years at Santa Barbara, there were, as observed 23 years of fair November rains; that is, rains of 1 inch or more. The outstanding facts are:

1. That though there were quite a number of dry seasons in southern California during this period, only one of them appears in the list shown in the table, the season of 1899–1900. And this exception, since it had the characteristic plateau high pressure of the drier seasons, can not be said to invalidate the theory of the significance of normal November rains with respect to the ensuing season. In November 1899 the storm that caused the normal monthly rainfall at Santa Barbara was intense enough to affect the southern coast in spite of the plateau high pressure, the rains being very heavy in the north and tapering off rapidly toward the south. Eureka had the extraordinary amount of 15 inches, and San Diego 0.35 inch.

2. Nineteen seasons out of the 23 having normal or over November rainfall had a rainfall of the average amount or more in the ensuing rainy season of southern California.

3. Central California had 22 seasons out of the 23 with seasonal rainfall of average amount or more, certainly a very striking fact.

To sum up inferences based on records of more than half a century, the conclusion is that fair November rains (1 inch or more) as far south as Santa Barbara forecast, for southern California with a probability of 83 per cent and for central California of 96 per cent, that an average to wet season will follow. That is to say, the probability of very dry seasons for southern California following fair November rains at Santa Barbara is 17 per cent, and for central California but 4 per cent. About four-tenths of the seasons of record have been preceded by such November rains. If this ratio to the total number of seasons continues as in the past, it would indicate that in somewhat less than half the years the above probabilities will be applicable. The writer wishes to emphasize here that the high probabilities above given relate not at all to the kind of seasons that have followed Santa Barbara November rains of less than 1 inch. There are several cases of normal or above normal seasonal rains following November rains of less than 1 inch; hence a "dry" November may mean either deficiency or excess to come. But, as shown, the "moderately wet" to "wet" Novembers have been followed in a very high percentage of cases by normal or above normal seasonal rains.

San Diego rains as an indication of the rainfall of the ensuing season.—In reviewing the rainfall records of San Diego my attention was called to the fact that San Diego occasionally has noticeable summer (July, August, and September) rains when no rains occur elsewhere on the coast at the same time, and that these summer rains have no apparent connection with those of Arizona.

The average total rainfall at San Diego for these three months is only 0.23 inch, due to the number of rainless seasons. These months as is well known, are characterized by semipermanent high pressure off the northwestern coast and by summer or heat LOWS over Arizona. The summer rains of San Diego seem to be of different origin from those of the interior; they come mainly from the southwest. They seem to indicate a more than normal intensity of the tropical cyclonic activity over the Pacific Ocean. These storms are sometimes first observed along the Mexican coast as far south as Mazatlan (latitude 22°) or else as coming in directly from the Pacific south of the thirtieth degree of latitude.

The great flood season of 1861–62 in California was preceded by excessively heavy rains early in the season at San Diego, when no rain at all fell north of Los Angeles. In October, 1883, a very heavy rain fell at San Diego in connection with a violent storm that moved northeastward from the Gulf of California (MONTHLY WEATHER REVIEW, October, 1883, p. 223), and the rainfall season of 1883–84 was very wet in both central and southern California. Late in September, 1921, a rain of 1.65 inches fell at San Diego and was hardly felt a little to the north. The storm track map of the month (MONTHLY WEATHER REVIEW, September, 1921), showed that this storm, of the hurricane type, was first observed opposite the Mexican tropical coast near Mazatlan. It then moved in a northwesterly direction and, turning inland near San Diego, took a northeasterly course. It was intense enough to cross the United States and pass out into the Atlantic. In the following December, LOWS of unusual extent appeared off the coast of southern California and gave nearly two weeks of rain. Again in January and February of the same season LOWS entered southern California with correspondingly heavy rains. The September LOW seemed thus a forerunner of them all.

At San Diego in the 72 seasons 1850–51 to 1921–22, there have been 21 summers with rainfall for July, August, and September totaling 0.21 inch or over the average for all summers being 0.24 inch. The rainfall of these 21 summers is given in Table 3, together with the respective ensuing seasons' total rainfall at six stations in southern California for which long records are available. Only the territory west of the mountain ranges is considered, since southeastern California has a desert climate. Now, assuming 0.21 inch to be an "average" summer rainfall at San Diego, the tabulation shows that 19 seasons out of the 21 that had average or more than average summer rains preceded average to

wet seasons in southern California. But the partially dry seasons of 1912–13 should properly be eliminated from this count, because its July and August rains, when traced to their origin with the aid of the Weather Bureau maps, are seen to be a result of the westward extension of interior LOWS, and therefore are rains from LOWS that did not come off the Pacific Ocean. Consequently, when we consider only the appreciable summer rains at San Diego due to LOWS that came in from the Pacific, *there are 19 seasons out of 20 that preceded average to wet seasons in southern California*, indicating a 95 per cent probability of similar occurrences for the future. The only regrettable fact is the infrequency with which these "average" summer rains occur.

TABLE 3.—*San Diego summer rains in relation to the ensuing rainy season in southern California*

Season	San Diego summer rainfall (normal 0.24″)	Seasonal rainfall at—					
		Los Angeles (normal 15.62″)	Redlands (normal 14.55″)	Riverside (normal 10.74″)	San Bernardino (normal 16.04″)	San Diego (normal 9.70″)	Tustin (normal 13.04″)
1852–53	0.40					11.03	
1853–54	.21					9.77	
1854–55	1.52					13.56	
1861–62	1.59					15.64	
1863–64	.36					5.14	
1865–66	1.29					12.82	
1867–68	.30					11.23	
1868–69	.56					11.68	
1873–74	1.95				23.81	7.88	
1874–75	.25				13.65	5.73	
1875–76	.60				19.90	10.11	
1880–81	.41	13.13			13.50	9.66	9.49
1890–91	.65	13.36	19.06	12.89	18.08	10.47	14.76
1902–3	.92	19.32	15.82	12.74	17.42	11.76	15.85
1905–6	.66	18.65	16.61	15.14	19.88	14.68	19.00
1906–7	.22	19.30	21.85	16.31	23.17	10.62	19.68
1908–9	.84	19.18	14.47	12.02	17.36	10.23	14.45
1912–13	.40	13.42	7.96	7.16	11.08	5.87	8.11
1916–17	.28	15.26	14.07	9.11	13.79	10.13	10.38
1919–20	.36	12.52	15.82	12.00	19.28	9.00	13.03
1920–21	1.24	19.66	25.50	19.75	27.75	18.65	17.51

In this connection, as with the results from my consideration of Santa Barbara rains, it should be stated that this high probability by no means indicates that we can forecast *in general* the seasonal rainfall from the summer rainfall. If the summer is "dry," it has no significance whatever in relation to the ensuing season's rainfall, for many wet seasons have followed almost rainless summers. But when the average to heavy summer rains do come, then the high probability above shown applies.

On examining the seasons above discussed, I find that nearly all of them had the South Pacific LOWS of September or October. When they have both the LOWS and the rains, the wetness of the coming rainy season is further assured.

DISCUSSION

By A. J. HENRY

The two articles immediately preceding deal with a question of great scientific and economic importance.

Blochman presents statistical evidence of the tendency of the weather to persist for a time in the same sense, an idea that has been discussed for some years in Europe. Von Hann in his Lehrbuch, third edition, refers to it under the caption "Die Erhaltungstendenz der Witterungstypen."[1] Others have alluded to it in connection with seasonal forecasting and only very recently Weise has computed the correlation coefficients between pairs of months, January–February, March–April, etc., for the 165-year temperature record for Leningrad,[2] first for the record as a whole, then for the three 50-year periods and finally for each of the five 30-year periods. The significant result is reached that the coefficients for corresponding pairs of months in some of the 30-year periods differ very materially from each other, whereas in the longer periods the coefficients are fairly uniform as between the several parts of the record.

Doctor McEwen utilizes ocean surface temperatures along the coast of southern California as an index to the pressure over the northeast Pacific and endeavors to pass from ocean pressures to the rains in a limited section of southern California six months later. The rather striking thing about this purely empirical method is that it gives the correct sign of the rainfall departure in eight out of nine cases, although the absolute amounts of rain are not indicated so closely.

Doctor McEwen in attempting to set forth his conception of the physical relations involved in the production of wet and dry years in California, is fully conscious of the difficulty of coordinating the very few facts at hand, and he therefore makes certain basic assumptions, some of which, in the view of the present writer may not be in accord with theory and experience. It is a question, indeed, whether scientific research of the present day is sufficiently well organized and equipped to cope with the truly great problem of seasonal weather forecasting, involving as it does the entire atmosphere of the globe. For more than 50 years meteorologists have been observing and charting the paths of anticyclones and cyclones; yet in all this time they have scarcely passed beyond the observing stage, for very little is yet known of the precise method of origin of these formations and the source of their maintenance as they travel over the face of the globe.

Out of the fifty-odd years of study have come the facts that cyclones with their attendant rain and cloud seemingly prefer to remain over the oceans in winter rather than pass on to the continents; also that their fullest development takes place over the oceans rather than the land.

It is also generally recognized that low surface temperatures over the land in winter, the presence of anticyclonic wind systems and perhaps still other causes, not yet clearly recognized, obstruct the free movement of cyclones especially over the land. These are some of the reasons why cyclones coming from the Pacific tend to incline toward the Gulf of Mexico and to enter the continent below 45° north latitude in some winters and not in others.

The rainfall in California is conditioned upon the pressure distribution over the Pacific to the west and also over the Great Basin and plateau region of western United States. In winter what may be called the North Pacific statistical anticyclone is at a minimum, and coincidently therewith the statistical anticyclone of the Great Basin is at a maximum. While the intensity of the latter by reason of being over the continent can be precisely delimited each winter, its oceanic counterpart is practically unknown.

It seems reasonable to endeavor to connect, as Doctor McEwen has attempted to do, the North Pacific statistical anticyclone with the weather in the United States. The descriptive term "statistical" is used to connote a pressure formation that is based upon the average pressures over a period longer than 24 hours, generally for a month.

[1] Lehrbuch der Meteorologie dritte auflage seite 629. See also Georgii, Walter: Wettervorhersage. Dresden, 1924.

[2] Met. Zeit. 42: 217–225, Wiese W, studien uber die Erhaltungstendenz der mittleren monatlichen Temperaturanomalien.

A study has been made of the monthly mean pressures, the prevailing winds, and their average speed for the two Pacific stations, Midway Island and Honolulu, also for the California coast stations with a view of discovering whether these marginal stations of the North Pacific statistical anticyclone show any evidence of fluctuations which might reasonably be ascribed to changes in the intensity or the geographic position of the latter. The result is a negative one, although it may be mentioned that the coastal stations give evidence of a continental rather than an oceanic control.

Anticyclones, whether of the daily migrating or the statistical sort, have a clearly recognized tendency to move equatorward and thus to successively pass into warmer and warmer regions. The winds in these formations blow outward at the surface and unless there is a corresponding inflow aloft, of which the evidence is either vague or lacking entirely, the anticyclone as such must carry within its organization the seeds of early dissolution.

Following the line of thought in the preceding paragraph, we are led to the conclusion that high pressure in the North Pacific statistical anticyclone in August, let us say, will not endure as such beyond a month or so at the utmost, and can not therefore be a significant factor in the weather of the Pacific coast six months later. This is not said with an air of finality, but rather it is what the writer's study and experience would lead him to expect.

The method of correlation coefficients does not yield significant results, nor could it be expected to do so, because no representative station lies within the central portion of the anticyclone we are considering. The greatest obstacle to reaching an early decision as to the influence of the pressure in late summer upon the weather of western United States six months later is the lack of pressure observations in the northeast Pacific or more specifically in the region included between the parallels of 35° to 50° north and the meridians of 135° to 170° west longtitude. Few ships navigate the central region of high pressure and the probability of an increase in the number of ships' reports is rather remote. What is needed is an exploring vessel to cruise in the region above outlined taking and reporting by radio, meteorogical observations daily for a period of, say, five years. More usable information will thus be accumulated than will be obtained in the next 50 years if we depend upon the voluntary taking of meterorological observations by what few ships navigate this area.

THE RAIN-BEARING WINDS AT ATLANTA, GA.

By CHARLES F. VON HERRMANN

[Weather Bureau, Atlanta, Ga.]

If almost any one in the eastern part of the United States be asked the question, "From what direction does the wind mostly blow during rain?" the answer will almost invariably be: "From an easterly direction, and when the wind shifts to northwest the weather will soon clear." However, in meteorology as well as in other sciences in order to be sure that a statement of this kind is correct we must have exact measurements. The most recent textbooks on meteorology do not discuss the subject of the rain-bearing winds in any detail, nor do the very complete reports on The Climate of Baltimore, by Fassig, and on the Weather and Climate of Chicago, by Cox and Armington, contain any information on this subject. Therefore it was thought worth while to investigate the matter carefully for a representative eastern station such as Atlanta.

Automatic hourly records of precipitation are available at Atlanta for the 20-year period from 1905 to 1924, inclusive, all taken at the same locality. The record includes the winter season. The occurrence of snow at Atlanta is so rare that on the few occasions when snow has fallen without melting as it fell the hourly amounts were estimated with a fair degree of accuracy and these estimates have been included to make the record complete. Accordingly the amount of rainfall for every hour, including traces, together with the prevailing direction of the wind during each hour and its velocity have been assembled for the entire period and tabulated by months and years.

Summarizing these results in Table 1, the hourly rainfalls and the corresponding prevailing hourly wind directions at the time of the rain, are given in percentages of the total, for eight wind directions, together with the mean velocities for the same directions. The total number of rain-wind hours for the 20 years is 19,311, the total rainfall 968.01 inches, and the mean wind velocity during rain-wind hours 9.7 miles per hour (against a mean velocity for all winds of 11.1 miles per hour), with the elevation of the anemometer always at 216 feet. The wind was calm during rain only three or four times during the period, and in these few instances a wind direction was assumed corresponding to the direction recorded during the preceding hour.

TABLE 1.—*Prevailing winds, amounts of precipitation, and average wind velocities during hours with rain*

Direction	Per cent	Amounts of precipitation (per cent)	Wind velocities (means)
North	3.9	4.9	5.6
Northeast	11.9	12.2	7.8
East	22.4	17.6	10.7
Southeast	20.7	20.3	11.5
South	10.8	12.4	9.0
Southwest	7.6	8.0	9.5
West	10.2	10.8	11.8
Northwest	12.5	13.8	11.7

The necessity for exact measurements is at once shown by the results of the investigation, for the answer given by the layman to the question, "What are the rain-bearing winds?" turns out to be only partially correct. For while the largest amounts of precipitation do occur with east and southeast winds, it happens that northwest winds are next in order and not last. In fact during May, June, possibly July, and August the greatest rainfall occurs with northwesterly winds and not with easterly winds. The exact results have considerable importance in making local weather forecasts for Atlanta and will be given in some detail here.

Results.—The most frequent direction of the wind at Atlanta during rain is east (22.4 per cent), but the largest amount of precipitation occurs with southeast winds (20.3 per cent). Northeast, east, and southeast winds together constitute 55 per cent of the rain-bearing winds, and the amount of precipitation is 50 per cent of the total. Next to the east and southeast, however, the

most frequent direction is northwest (11.5 per cent) and the greatest total rainfall 13.8 per cent.

Apparently the driest winds are from the north, but for certain topographical reasons north winds are infrequent at Atlanta. The really dry wind is the southwest, 7.6 per cent, and total rainfall 8 per cent.

The explanation of these results appears to be quite simple. Most of the rains in winter are of cyclonic origin and chiefly accompany barometric depressions that move from the southwest, or mostly from Texas, toward the northeast either over or north of Georgia; therefore the rainfall occurs chiefly with east to southeast winds. On the other hand a majority of the disturbances that move eastward across the Ohio Valley or Lake region cause much less precipitation in Georgia; the winds then remain east or southeast for only brief periods and the southwest becomes the prevailing wind and is comparatively a dry wind. But why does so much rain fall with northwest winds in summer? Probably because most of it accompanies thunderstorms. During the approach of thunderstorms, nearly always from a westerly direction, the wind may be for a brief period from the east or southeast, but there is generally little rain until the outrushing westerly or northwesterly wind sets in; in fact during many thunderstorms the wind is mostly northwest during the entire time rain continues to fall. It is to be observed also that not only are the rain-bearing winds northwest in summer but they are not even as dry as the north or southwest winds during any season of the year.

The annual average wind velocity at Atlanta, all records considered, at the present elevation of the anemometer is 11.1 miles per hour. The average velocities for only the southeast, west, and northwest rain-bearing winds exceed this, being respectively: Southeast, 11.5 miles per hour; west, 11.8 miles per hour; and northwest, 11.7 miles per hour.

TABLE 2.—*Monthly percentage frequency of rain-bearing winds at Atlanta*

Direction	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
North	2.5	3.2	4.1	2.4	3.5	4.6	3.2	5.2	7.3	5.9	5.3	2.9	3.9
Northeast	9.9	15.9	10.4	9.1	8.0	9.9	7.7	9.2	20.5	19.8	9.7	13.3	11.9
East	29.9	27.3	21.7	17.4	20.8	15.4	12.5	12.9	25.8	24.3	24.5	25.7	22.4
Southeast	17.4	21.0	23.2	21.8	22.9	13.9	24.3	19.1	16.6	20.9	22.0	22.8	20.7
South	7.5	9.4	11.0	13.4	14.6	10.2	14.2	12.7	8.1	8.3	12.1	10.1	10.8
Southwest	5.9	4.7	6.2	10.6	8.2	12.8	12.9	13.2	5.6	3.9	5.4	6.4	7.6
West	12.0	5.7	7.3	12.1	10.4	17.0	14.1	14.2	7.4	6.6	9.7	9.3	10.2
Northwest	14.9	12.8	16.1	13.2	11.6	16.2	11.1	13.5	8.7	10.3	11.3	9.5	12.5

The total amounts of precipitation with each rain-bearing wind do not follow quite the same course, though very nearly so. Table 3 gives the amounts of precipitation with each direction in percentages of the total rainfall.

TABLE 3.—*Monthly percentage of the total rainfall for each wind direction*

Direction	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov	Dec.	Year
North	5.4	5.3	4.7	3.3	3.2	8.4	4.2	4.1	7.5	5.7	4.8	4.3	4.9
Northeast	13.1	18.7	9.6	8.5	7.1	16.6	6.6	9.4	13.8	21.8	12.4	13.0	12.2
East	20.5	20.4	17.1	13.9	16.3	11.9	12.4	12.6	18.6	20.6	17.5	20.2	17.6
Southeast	15.8	23.0	24.0	22.8	17.0	11.4	27.3	13.2	21.4	16.5	25.5	23.9	20.3
South	5.7	11.1	14.6	15.8	16.6	7.5	13.7	16.5	7.2	6.9	15.6	13.7	12.4
Southwest	4.5	6.5	7.2	9.5	8.8	11.2	10.3	11.1	7.7	6.7	8.3	6.5	8.0
West	9.1	6.8	8.8	12.4	13.4	14.4	13.6	14.5	9.4	9.9	7.1	9.1	10.8
Northwest	16.9	8.2	14.0	13.8	17.6	18.6	11.9	18.6	14.4	11.9	11.8	9.3	13.8

The data given in these tables are represented graphically by Figure 1 for the prevailing directions and Figure 2 for the amounts of precipitation and mean wind velocities.

The differences between the winter and summer months is rather striking, as shown by the diagrams for each month and by Table 4. In January the maximum percentage of precipitation occurs with east winds (29.5 per cent); for the directions northeast, east, and southeast the total amount is 58.4 per cent. In February the largest amounts occur with southeast winds (23 per cent), although the total for the three directions, northeast, east, and southeast, is still the greatest, namely, 62.1 per cent. In March and April the maximum rain-

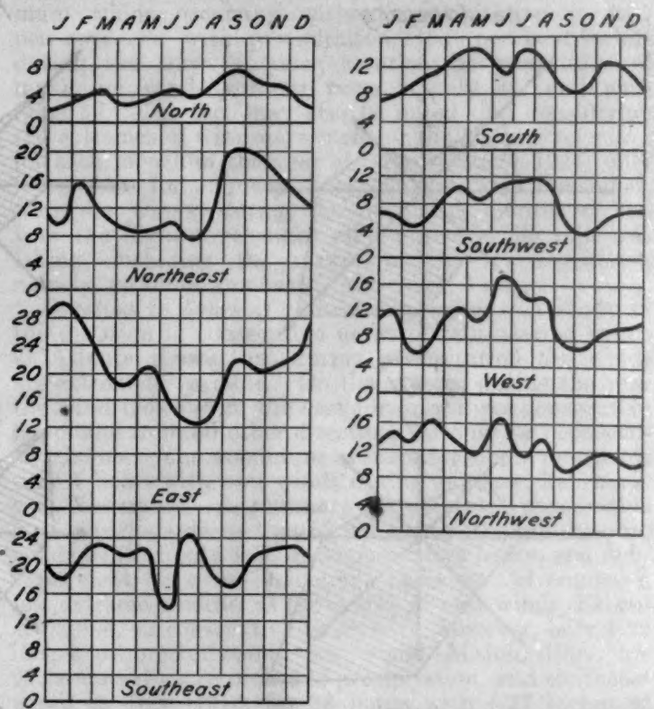

FIG. 1.—Hourly frequency of rain-bearing winds at Atlanta, Ga., for the 20-year period 1905–1924, in percentages of the annual total number of wind directions registered during precipitation

fall has shifted to the southeastern quadrant. In May the largest amounts occur with northwest winds, although the southeast quadrant still retains the maximum total for three directions. But in June the shift to west is complete: Northwest, 18.6 per cent and southwest, west, and northwest, 44.2 per cent. August is identical—northwest, 18.6 per cent, and southwest, west, and northwest, 44.2 per cent. But the intermediate month of July is peculiar, for although the maximum precipitation in July occurs also with northwest winds (17.6 per cent) the southeastern quadrant again shows a maximum for three directions. But this result is entirely due to the fact that during July, 1916, a series of cyclonic depressions (subtropical storms) from the southwest caused unusually heavy rains, with continuous southeast winds for nearly four days (95 hours southeast, with 7.66 inches of rainfall, the number of hours southeast is more than one-third of the total number of times the wind was southeast during the entire 20-

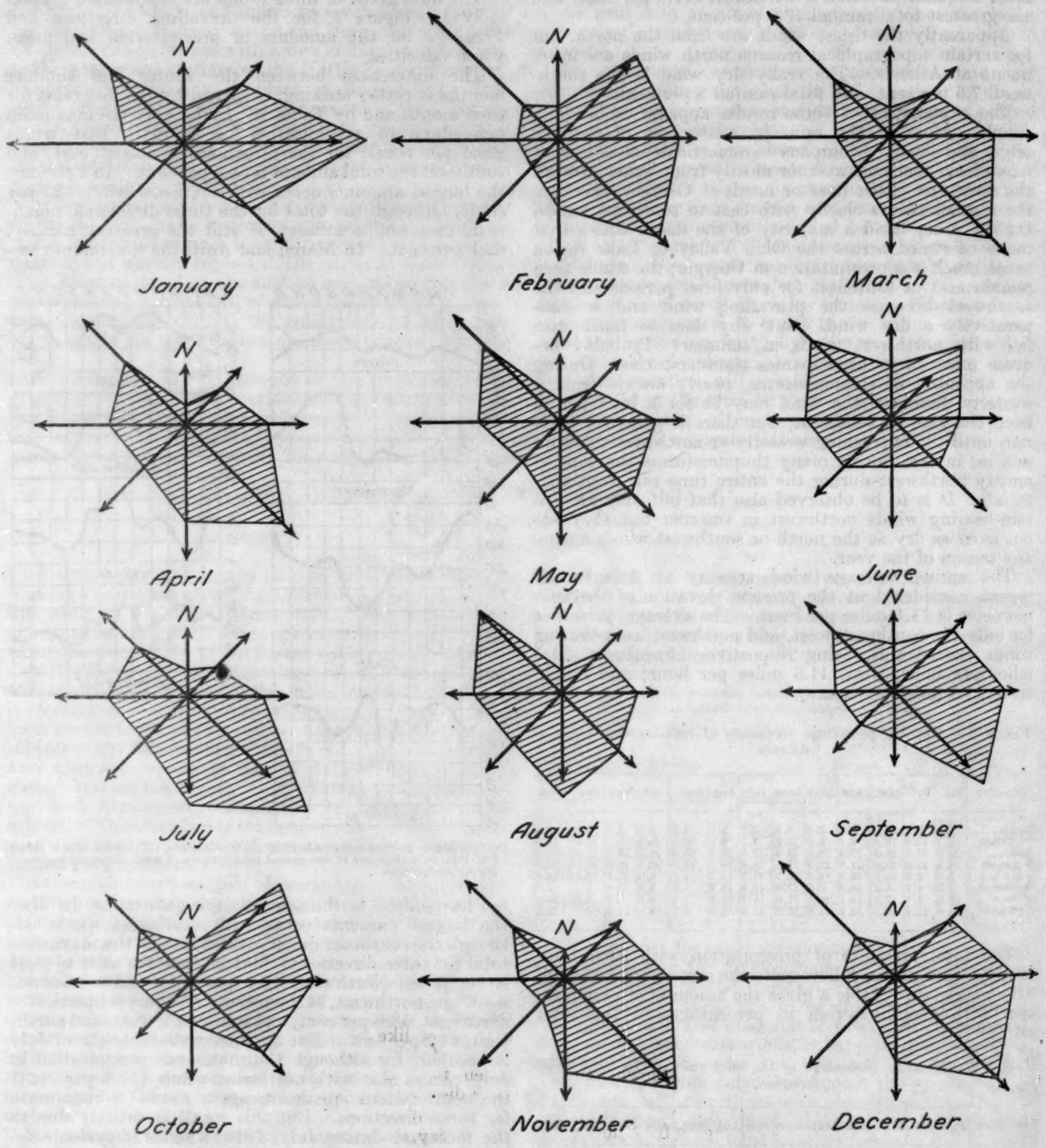

FIG. 2.—Total precipitation, for each direction of the wind, in percentages of the annual total rainfall (read from the origin to the angles of the polygons), and the average velocity of rain-bearing winds, at Atlanta, Ga., for the 20-year period, 1905–1924

year period.) Omitting July, 1916, the record becomes quite similar to that for August.

In September and October there is a backward swing to maximum rainfall during easterly winds, September northeast, east, southeast, 53.8 per cent, and October northeast, east, southeast, 58.9 per cent, with even the maximum as far around as northeast in October, namely, 21.8 per cent; but during November and December the heaviest rains again occur with southeasterly winds.

The most frequent rain-bearing winds for the year are northeast, east, and southeast, with a total of 62.1 per cent in February, and the driest winds are south, southwest, and west, with 19.3 per cent in January.

It is rather remarkable that the intensity of the rainfall is so nearly the same for each direction of the wind, ranging only from 0.04 inch an hour during east winds to 0.06 per hour during northwest winds, with an average for all other directions of 0.05 inch. Excluding "traces," the hourly intensity (total rainfall divided by the number of hours with 0.01 inch or more) is 0.08 inch.

TABLE 4.—*Wind directions with which occur the average maximum and the average minimum percentage of the total monthly precipitation, 12 months, Atlanta, Ga., together with direction of rain-bearing wind showing average maximum velocity*

	Rainfall and wind directions		Direction showing average maximum wind velocity (m. p. h.)
	Maximum percentage	Minimum percentage	
January	E, 29.5 NE.+E.+SE., 58.4	SW., 4.5 S.+SW.+W., 19.3	W., 14.6.
February	SE., 23.0 NE.+E.+SE., 62.1	N., 5.3 N.+NW.+W., 20.3	NW., 14.7.
March	SE., 24.0 E.+SE.+S., 55.7	N., 4.7 N.+NW.+W., 27.5	NW., 14.2.
April	SE., 22.8 E.+SE.+S., 52.5	N., 3.3 NW.+N.+NE., 25.6	SE., 13.0.
May	NW., 17.6 E.+SE.+S., 49.9	N., 3.2 E.+NE.+N., 26.6	W., 12.3.
June	NW., 18.6 SW.+W.+NW., 44.2	S., 7.5 SE.+S.+SW., 30.1	NW., 11.4.
July	SE., 27.3 E.+SE.+S., 53.4	N., 4.2 NW.+N.+NE., 22.7	W., 10.8.
August	NW., 18.6 SW.+W.+NW., 44.2	N., 4.1 N.+NE.+E., 26.1	NW., 18.6.
September	SE., 21.4 NE.+E.+SE., 53.8	S., 7.2 S.+SW.+W., 24.3	E., 10.7
October	NE., 21.8 NE.+E.+SE., 58.9	N., 5.7 S.+SW.+W., 23.5	SE., 11.1.
November	SE., 25.5 E.+SE.+S., 58.6	N., 4.8 SW.+W.+NW., 24.2	W. and SE., 12.2.
December	SE., 23.9 E.+SE.+S., 57.8	N., 4.3 SW.+W.+NW., 24.9	NW. and SE., 13.2.

Maximum wind velocities during rain.—The record of maximum velocities during rain shows a very pronounced crest for west and northwest winds. Of the total number of maximum velocities exceeding 24 miles an hour during precipitation 52 per cent occurred with west and northwest winds and 30 per cent with east and southeast winds.

During the period of 20 years from 1905 to 1924 maximum wind velocities exceeding 24 miles an hour with and without rain occurred 10,761 times. Computed in percentages of the monthly totals, it appears that 72.6 per cent of the maximum winds occurred without precipitation, and 27.4 per cent during rains. But the distribution by months is rather peculiar and bears out the explanation why the maximum rainfall occurs during summer with northwest winds. During the period from September to May, inclusive, the percentage of maximum winds occurring without precipitation is 83.2 per cent and with precipitation, 16.8 per cent, while during the three summer months the percentage of maximum winds without rains is only 41, and with rains 59. The fact may also be noted that considering the extremes of wind movement or the highest velocities for each month of the year at Atlanta (1879–1924) only four, those for January, July, August, and December, were dry winds; during the remaining months of the year the highest velocities all occurred while rain was falling, including the maximum velocity registered, namely, 66 miles northwest, March 24, 1909.

Duration in hours of rain-bearing winds.—A study of the duration in consecutive hours of rain-bearing winds at Atlanta shows that during precipitation the winds are extremely variable. On the average during the year the wind blows from the east for only three consecutive hours and from all other directions for only two consecutive hours. The maximum average for single months is only 4 hours with east winds during January, February, and November. A summary of the total consecutive hourly periods shows that 88 per cent of the rain-bearing winds last for only 1, 2, or 3 consecutive hours, and only 1 per cent for over 12 hours. There are, of course, a few extreme records, as for example: east winds, February, 1908, 42 consecutive hours with, however, only 1.22 inches of precipitation; east winds, March, 1909, for 25 hours with 2.20 inches of precipitation, and southeast winds in July, 1916, for 38 hours with 4.27 inches of precipitation; but these are the only cases on record in 20 years when the rain-bearing winds lasted for more than 24 hours from the same direction.

NOTES, ABSTRACTS, AND REVIEWS

PRECIPITATION IN THE FORM OF ICE SPICULES AT TEMPERATURES NEAR FREEZING

By FRED H. WECK

(Springfield, Illinois)

On Saturday, November 7, 1925, there occurred at Springfield a light fall of snow that was somewhat out of the ordinary.

It had been raining all day and the pressure started to rise at 4:00 p. m., with the wind changing from northeast to northwest. At 6.25 p. m., with a temperature of 34°, small irregular-shaped particles of ice began falling with the rain. It was sleet. About 7:45 p. m., the temperature being 29°, the sleet was mixed with ice needles. They were examined at intervals until about 8:30 p. m., when all the precipitation falling was in the form of the spiculæ, the temperature having fallen to 27°. They were observed under a glass and were found to be of different lengths, some of them nearly one-sixteenth inch long, but most of them approximately one thirty-second inch or less. They were neither clear nor perfectly white, but when piled up looked at a distance of a few feet like ordinary snow. Each needle had very minute feathery projections on the sides. Care was taken to find some hexagon-shaped flakes but none were discovered. * * *

The above observation was submitted to Mr. Wilson A. Bentley, of Jericho, Vt., who commented as follows:

I have observed and photographed the ice spiculæ form of snow crystal, many times here in Jericho, although they are relatively rare. They usually fall during mild temperature and always, so so far as I have observed, from low-lying clouds. They seem very similar to the needle form of cloud frost that forms apparently from cloud droplets, and attach themselves to tree twigs, etc., on mountain tops. My belief is that this form of snow crystal is suberystalline in nature, and due to the joining of many fluid cloud droplets one to another to form a rod-shaped ice spicula.

Milham says:

If the temperature is very low—at least below zero Fahrenheit—fine ice needles are formed instead of snowflakes.[1]

In Davis' Elementary Meteorology we read:

When precipitation occurs in the polar regions at temperatures lower than −5° to −10° small ice needles and not snowflakes are formed.[2]

The observation on November 7, and Mr. Bentley's experience, show that the ice needle form of snow crystal does occur at temperatures considerably higher than is generally supposed. * * *

PHYSICAL OCEANOGRAPHY AND MARINE METEOROLOGY OF THE PACIFIC

At the Scripps Institution of Oceanography, La Jolla, Calif., on November 6 and 7, 1925, was held a conference for the discussion of the bearing of the physical oceanography and marine meteorology of the Pacific upon the climate of the western United States. Dr. T. W. Vaughan, Director of the Scripps Institution, outlined in effect the objects of the conference as follows:

The object of the conference is to bring together for mutual benefit representatives of those interested in the study of the physical features and the meteorology of the northeastern part of the Pacific and those wishing to apply results of such studies to investigations of the climate of the western part of the United States. Special attention is directed to the problem of fog forecasting and seasonal rainfall forecasting. Therefore representatives of the United States Navy, Coast and Geodetic Survey, Weather Bureau, of those engaged in hydroelectric power development, the use of water for irrigation, farm management, and forest protection were invited to join with the institution staff to consider problems of mutual concern. * * * The conference should also help prepare the American representatives for their part in the science congress to be held in Japan during October and November, 1926.

Progress in obtaining ocean water temperatures in the Pacific was outlined by Dr. G. F. McEwen, an abstract of whose paper follows:

PRELIMINARY REPORT ON OCEANOGRAPHIC OBSERVATIONS FURNISHED BY THE UNITED STATES NAVY DURING RECENT MANEUVERS IN THE PACIFIC

A program was planned involving hourly measurements of sea temperatures by means of thermometers already attached to condenser intakes for the use of engineering departments. Opportunities were provided for calibrating the thermometers with which the destroyer fleet of 30 ships are equipped. During the maneuvers of the fleet in the Pacific from April to October, 1925, over 22,000 temperature observations were made, over 1,000 water samples, and about 260 plankton catches were collected. During April there were 6,400 temperatures and 400 water samples taken on a cruise from San Diego southwest 200 miles to Guadaloupe and return; San Francisco to Hawaii, 7,500 temperatures and 650 water samples; Hawaii to Australia and New Zealand, returning by way of Samoa, 6,600 temperatures, 160 water samples, 200 plankton catches. A preliminary examination of part of the data indicated a very good agreement between the results. Such intensive data are well suited to give detailed information on horizontal temperature gradients of interest in certain meteorological problems. Such information also constitutes a basis for estimating the rate of flow in ocean currents. The practicability of making such observations having been thus demonstrated, similar programs will probably be arranged in the future, thus providing an ever-increasing amount of intensive observations and collections at the surface that could not be obtained in any other way.

The outlook for solving the problem of fog forecasting was discussed by Mr. Dean Blake, meteorologist of the San Diego station of the Weather Bureau, who pointed out that correlation of data from land, sea, and air may yield rules that should improve the percentage of accuracy of fog predictions. Maj. E. H. Bowie, district forecaster at San Francisco, dealt with "The Northeast Pacific Anticyclone and Its Relation to California Climate." Doctor McEwen reviewed his work of the past nine years on the relation between ocean temperatures and seasonal rainfall. (See his paper in this Review.) A. Wilstam, of the southern California Edison Co., in a paper on the application of Doctor McEwen's seasonal rainfall forecasts to forecasting the seasonal water supply for hydroelectric plants, showed that:

The summer ocean temperature data supplied by the Scripps Institution are found to be closely enough correlated with the following seasonal rainfall to be given consideration in preparing the yearly budget of the Southern California Edison Co.; 7 to 8 indications out of 9 have proved to be in the right direction.

Edgar Alan Rowe discussed "The Value of Long Range Rainfall Forecasting to Irrigation and Water Supply Projects in Southern California from an Engineering Standpoint"; James G. France, "Seasonal Forecasting and its Value to the Agriculturist in San Diego County"; and J. E. Elliott, "Seasonal Forecasting and its Bearing on Forestry Problems." Abstracts of the four papers last mentioned appear in the December, 1925, issue of the Bulletin of the American Meteorological Society.—*B. M. V.*

TORNADO NEAR SALEM, IN THE WILLAMETTE VALLEY, OREG.

Mr. E. L. Wells, meteorologist in charge of the Portland, Oreg., station of the Weather Bureau, sends a detailed account of his investigations into the reported occurrence of a tornado in the Willamette Valley on November 11, 1925. The following paragraph gives his conclusions:

It is quite evident that the storm was a rather poorly defined tornado, which reached the ground at a few places in a path extending from a point north of Independence to a point in the Liberty district, southwest of Salem, a distance of about 5 miles; at no place was the path well outlined, as for the most part damage was confined to old, weak structures, and others escaped injury; the destruction was mostly confined to the right side of the path, where the whirl was moving in the same direction as the whole storm, and therefore most of the wreckage was carried forward.

Mr. Wells states that this appears to be the first tornado observed west of the Cascade Range in Oregon.—*B. M. V.*

METEOROLOGICAL SUMMARY FOR SOUTHERN SOUTH AMERICA, NOVEMBER, 1925

By Senor J. B. NAVARRETE

[El Salto Observatory, Santiago, Chile]

[Translated by B. M. V.]

The month of November was characterized in general by a relatively stable condition of the atmosphere, in which the southern anticyclone was frequently the dominating feature, favoring rising temperatures and hot waves in the central zone.

The early days of the month had generally good weather, but with violent winds between the coasts of Chiloe and Arauco, with fairly high temperatures in the interior of the Provinces of Aconcagua, Santiago, O'Higgins, Colchagua, Curico, and Talca. The high-pressure center was situated during this period between Chiloe and Cape Raper, fluctuating about a mean value of approximately 770 mm. (1,026 mb.).

[1] Milham's Meteorology, p. 241.
[2] Davis' Elementary Meteorology, p. 286.

On the 11th, an important atmospheric depression appeared in the west and affected the southern zone, causing bad weather with violent winds and rain between Concepcion and Chiloe Provinces. This was the beginning of a period of frequent atmospheric changes in the southern zone which lasted until the 23d; depressions succeeded one another at intervals of two to four days as they crossed the southern area. During this period, temperatures were moderate in the south and high in the central zone where fine weather was persistent.

On the 24th the southern anticyclone reestablished itself and lasted until the end of the month; during this period general fine weather prevailed, with southerly winds; the temperature rose rapidly, causing intense hot waves in the central zone, with maximum temperatures of 33° C. (91° F.) in the shade.

METEOROLOGICAL SUMMARY FOR BRAZIL, NOVEMBER, 1925

By J. DE SAMPAIO FERRAZ

(The Meteorological Office, Rio de Janeiro)

The country was visited by four anticyclones the tracks of which were irregular and abnormally far south on account of the activity of the continental LOW.

The first two HIGHS appeared in the Argentine on the 9th and 12th respectively, both deflected to a southerly track by the continental depression. From the 13th to 19th this system dominated the whole center and south of the continent.

The third anticyclone made its appearance on the 20th, following the usual northeastern track, with "surges." The last HIGH, the largest of the month, was first seen on the chart of the 24th, bringing down the temperature generally and producing fresh winds in the south on the 25th, 26th and 27th, on account of the strong contrast in pressure between it and the continent LOW, whose occasional vigorous activity was the leading feature of the month.

Rains were generally plentiful in the center and south, excepting in Bahia, although irregular in distribution in some States. In northern Brazil precipitation was below normal, perhaps because of the southern position of the tracks of the anticyclones. Rio de Janeiro had a cool, damp, and unsettled November. On the 29th the city was struck by a passing gale.

Crops were generally good. Cotton harvesting continued, but the crop was less plentiful than in the previous year. Coffee, as indicated by actual yield, will not give a normal crop, having suffered from earlier droughty conditions, although the weather of the present month ran favorably. Cane, cocoa, and tobacco were in good condition, but slightly damaged in the north by rain deficiency.

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SOLAR OBSERVATIONS

SOLAR AND SKY RADIATION MEASUREMENTS DURING NOVEMBER, 1925

By HERBERT H. KIMBALL, Solar Radiation Investigations

For a description of instruments and exposures and an account of the method of obtaining and reducing the measurements, the reader is referred to the REVIEW for January, 1924, **52**: 42 and January, 1925, **53**: 29.

From Table 1 it is seen that solar radiation intensities averaged above the normal for November at Washington, D. C., and slightly below at Madison, Wis., and Lincoln, Nebr.

Table 2 shows that the solar and sky radiation received on a horizontal surface averaged slightly below the normal for November at Washington and above normal at Madison and Lincoln.

At Washington skylight polarization measurements made on four days give a mean of 63 per cent, with a maximum of 66 per cent on the 9th. At Madison, measurements made on five days give a mean of 61 per cent with a maximum of 66 per cent on the 20th. The values for Washington are close to the November averages, while those for Madison are somewhat below.

TABLE 1.—*Solar radiation intensities during November, 1925*

Washington, D. C.

[Gram-calories per minute per square centimeter of normal surface]

Date	Sun's zenith distance: 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.					P. M.				Local mean solar time
	e.	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e.
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
Nov. 9	3.30	.....	0.81	1.02	1.26	1.49	1.18	1.05	0.92	0.80	2.36
10	3.30	0.71	0.84	1.00	1.13	1.41	1.21	.....	.....	.....	3.15
11	4.75	0.55	0.73	0.91	1.14	.....	1.11	0.94	0.83	0.76	4.57
13	7.29	0.71	.....	.....	1.18	.....	.....	.....	.....	.....	6.50
14	4.75	0.92	1.06	1.19	1.40	1.56	1.37	1.18	1.06	0.97	3.63
18	3.30	1.01	1.08	1.19	1.33	.....	.....	.....	.....	.....	3.63
21	4.37	0.63	0.76	0.93	1.16	1.43	1.18	1.02	0.86	0.77	4.57
23	2.36	.....	.....	.....	1.30	.....	.....	.....	.....	.....	1.96
24	1.68	.....	0.81	0.96	1.21	.....	1.21	.....	.....	.....	2.16
Means	.....	0.76	0.87	1.03	1.23	1.47	1.21	1.05	0.92	0.82	.....
Departures	.....	+0.01	+0.02	+0.04	+0.05	.....	+0.04	+0.07	+0.10	+0.09	.....

TABLE 1.—*Solar radiation intensities during November, 1925*—Con.

Madison, Wis.

Date	Sun's zenith distance: 8 a.m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	Noon
	75th mer. time	Air mass: A. M.					P. M.				Local mean solar time
	e.	5.0	4.0	3.0	2.0	[1] 1.0	2.0	3.0	4.0	5.0	e.
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
Nov. 5	4.17	.....	.....	.....	.....	.....	.....	1.22	.....	.....	4.72
6	3.45	.....	.....	0.82	1.31	.....	.....	.....	.....	.....	4.37
11	4.75	.....	.....	.....	.....	.....	.....	0.95	.....	.....	6.50
13	6.02	.....	.....	.....	1.22	.....	.....	1.08	.....	.....	6.76
17	2.62	.....	.....	1.09	1.24	.....	.....	.....	.....	.....	3.81
20	3.63	0.87	1.00	1.08	1.28	.....	.....	1.21	0.96	.....	5.16
21	4.37	0.85	0.97	1.11	1.28	1.47	.....	.....	.....	.....	4.57
23	1.88	.....	0.91	1.16	.....	.....	.....	.....	.....	.....	2.16
25	3.63	0.83	.....	.....	.....	.....	.....	.....	.....	.....	3.63
28	1.19	1.09	1.19	1.31	.....	.....	.....	.....	.....	.....	1.19
Means	.....	0.91	1.02	1.10	1.27	)	.....	1.12	(0.96)	.....	.....
Departures	.....	+0.03	+0.01	−0.05	−0.03	.....	.....	−0.04	−0.10	.....	.....

Lincoln, Nebr.

Nov. 2	3.99	.....	0.99	1.12	1.32	.....	1.20	.....	.....	.....	4.57
5	3.81	.....	0.87	1.21	.....	.....	1.31	1.13	.....	.....	4.57
8	1.88	.....	1.02	1.17	1.34	1.52	1.31	1.17	1.02	0.91	2.87
9	3.30	0.74	0.87	1.15	1.37	.....	.....	.....	.....	.....	5.36
10	3.30	0.79	0.83	0.98	1.13	.....	1.28	1.05	0.92	0.80	7.04
11	4.75	0.92	1.03	1.14	1.27	.....	.....	.....	.....	.....	6.76
12	4.75	.....	.....	.....	.....	.....	1.26	1.15	.....	.....	7.04
16	2.74	.....	.....	.....	.....	.....	1.23	1.19	1.05	0.98	3.99
18	4.17	.....	.....	.....	1.35	1.56	1.41	1.26	1.10	.....	4.75
19	3.45	0.94	1.09	1.18	1.41	1.60	1.40	1.27	1.13	1.02	4.95
20	3.30	0.90	0.96	1.22	1.41	1.63	.....	1.26	1.13	1.02	5.36
21	3.45	.....	0.76	1.26	.....	.....	.....	.....	.....	.....	4.17
30	3.99	.....	.....	1.26	1.40	.....	.....	.....	.....	.....	4.17
Means	.....	0.86	0.94	1.17	1.33	1.58	1.30	1.18	1.06	0.95	.....
Departures	.....	−0.07	−0.09	−0.02	−0.02	.....	−0.06	−0.02	+0.01	+0.01	.....

[1] Extrapolated.

TABLE 2.—*Solar and sky radiation received on a horizontal surface*

[Gram-calories per square centimeter of horizontal surface]

Week beginning—	Average daily radiation: Washington	Madison	Lincoln	Chicago	New York	Average daily departure from normal: Washington	Madison	Lincoln
1925	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Oct. 29	208	212	261	161	152	−37	+25	+13
Nov. 5	206	183	251	151	134	−17	+14	+19
12	188	129	226	87	140	−11	−19	+11
19	229	152	228	147	114	+53	+18	+26
26	145	117	180	75	98	−13	−8	−8
Excess or deficiency since first of year on Dec. 2						−987	+21	−2,072

WEATHER OF NORTH AMERICA AND ADJACENT OCEANS

NORTH ATLANTIC OCEAN

By F. A. YOUNG

The following table shows the average sea-level pressure and departure for the month as well as the highest and lowest barometric readings at a number of land stations on the coast and islands of the North Atlantic. The readings are for 8 a. m. 75th meridian time, and the departures are only approximate, as the normals are taken from the Pilot Chart and were based on Greenwich mean moon observations, which correspond to those taken at 7 a. m., 75th meridian time.

Station	Average pressure	Departure	Highest	Date	Lowest	Date
	Inches	*Inches*	*Inches*		*Inches*	
St. Johns, Newfoundland	29.94	0.00	30.34	[1] 12th	29.14	15th.
Nantucket	30.09	0.00	30.60	30th	29.34	14th.
Hatteras	30.17	+0.05	30.44	[1] 5th	29.70	13th.
Key West	30.03	+0.01	30.28	17th	29.76	30th.
New Orleans	30.15	+0.04	30.56	17th	29.74	12th.
Swan Island	29.87	−0.05	29.96	[1] 17th	29.76	4th.
Turks Island	30.01	0.00	30.08	[1] 7th	29.88	23d.
Bermuda	30.14	+0.06	30.40	19th	29.76	24th.
Horta, Azores	30.05	−0.07	30.42	9th	29.70	2d.
Lerwick, Shetland Islands	29.90	+0.20	30.49	[1] 17th	29.44	9th.
Valencia, Ireland	29.89	+0.09	30.04	10th	28.98	7th.
London	29.94	0.00	30.51	19th	29.02	7th.

[1] And on other dates.

The number of days with winds of gale force was not as large as in October, which was an unusually stormy month, and over the steamer lanes the conditions did not differ materially from the normal for November, as shown on the Pilot Chart. The most unfavorable weather occurred west of the 50th meridian, between the 30th and 45th parallels, where gales were reported on from 3 to 8 days. In the 5-degree square that includes Tampico, Mexico, gales were reported on 4 days and in the square between the 25th and 30th parallels and the 85th and 90th meridians, on 3 days.

The number of days with fog over the Grand Banks and off the New England coast was greater than in October, but less than the normal for the current month for these localities; judging from reports received, the middle and eastern sections of the steamer lanes were comparatively free from fog.

The disturbance that on October 31 was over the middle section of the steamer lanes moved steadily eastward, and on November 1 was central near 53° N., 23° W., where a barometric reading of 28.73 inches was recorded, and winds of gale force swept the ocean east of the 50th meridian. This LOW apparently moved but little during the next 24 hours, and on the 2d the storm area had contracted considerably in extent, and moved south from its former position, as southerly gales now prevailed in the vicinity of the Azores.

On the 3d northwesterly gales occurred over the middle section of the northern steamer lanes, and there was also a slight depression near the Bermudas that afterwards developed into a severe disturbance.

On the 4th the conditions had changed but little since the previous day, and the southern depression was central near 35° N., 55° W. While moderate winds prevailed in this vicinity at the time of observation, heavy weather was encountered later in the day, as shown by storm reports. On the 4th northeasterly gales were reported from the region between the Bermudas and American coast, accompanied, in some cases, by comparatively high barometric readings. Easterly winds of gale force also occurred in the Gulf of Mexico.

Charts VIII to XI cover the period from the 5th to 8th, inclusive, when unusual conditions prevailed due to the slow moving southern depression and the fast traveling northern LOW that was responsible for very stormy weather over the steamer lanes. This was an unusually severe and protracted storm, and caused considerable damage to shipping and delay in the passage of a number of vessels.

On the 9th the northern disturbance was still over the North Sea and the southern LOW had moved but little since the previous day. They had both decreased in intensity and moderate weather was the rule except over a limited region off the South European coast where moderate northwesterly gales continued.

By the 10th the southern depression had filled in and the northern disturbance was no longer within the limits of the chart. On this date another LOW began to develop over the region between Greenland and Newfoundland, although at the time of observation moderate winds were the rule. On the 10th northwesterly winds of gale force were also reported from the western portion of the Gulf of Mexico.

On the 11th westerly gales, accompanied by hail and snow, were encountered in the middle section of the steamer lanes and northeasterly gales off the coast of Portugal. At the time of observation on the 11th moderate winds were reported from the Gulf of Mexico that increased to gale force later in the day.

On the 12th westerly gales continued in mid-ocean and southeasterly gales prevailed along the American coast between Chesapeake Bay and Florida.

On the 13th the American coast LOW was central near Nantucket, the storm area extending from Bermuda to Maine. This disturbance moved but little during the next 24 hours, but by the 14th the storm area was north of its former position and now covered the region between the 35th parallel and Newfoundland. On the same day there was a depression near the Azores that afterwards developed into a disturbance of moderate force and extent.

On the 15th a trough of low pressure extended from the north into the Gulf of Mexico near Pensacola, where a barometric reading of 29.76 inches was recorded, while at Brownsville, Tex., the reading was 30.24 inches. As a result of the steep pressure gradient heavy northerly gales were encountered in the western portion of the Gulf, between the 90th meridian and Mexican coast. On the 15th gales were also encountered over the greater part of the steamer lanes, west of the 30th meridian, and the southern depression of the 14th was now central near 40° N., 15° W.

On the 16th there was a LOW over Quebec, and heavy winds prevailed between the 30th and 45th parallels, west of the 65th meridian. On the same day there were also two LOWS over the ocean; the first near 50° N., 37° W., and the southern depression that had moved but little since the 15th.

On the 17th the Canadian disturbance was central near Father Point, and westerly gales prevailed along the coast between Hatteras and Newfoundland. The LOW that was in mid-ocean on the 16th moved rapidly northeastward, losing in intensity, and on the 17th was probably somewhere in the vicinity of Iceland, although it was impossible to plot its position accurately, due to

lack of observations. The southern depression, remaining nearly stationary off the coast of Portugal, had begun to fill in, and moderate weather prevailed in the vicinity.

On the 18th the western LOW was central near Belle Isle, and northerly to northwesterly gales were encountered by vessels in the southerly quadrants, the storm area extending as far south as the Bermudas.

From the 19th to the 21st moderate conditions were the rule over practically the entire ocean, although there was a slight depression between the 35th meridian and Madeira that was accompanied by winds of moderate gale force over a limited area.

On the 22d there was a LOW central near St. Johns, Newfoundland, where moderate winds prevailed at time of observation, although afterwards increasing in intensity as it moved northeastward. On the 22d westerly winds of moderate gale force occurred in the Caribbean Sea, as shown by report in table.

On the 23d Nantucket was near the center of a LOW, and storm reports were received from vessels in the southerly quadrants as well as those in mid-ocean.

On the 24th there was a disturbance central near Father Point that moved rapidly eastward, and on the 25th was over eastern Newfoundland. On both of these dates gales were reported from a limited region north of the 40th parallel, between the 50th and 60th meridians.

On the 26th the center of this disturbance was near Belle Isle, and moderate gales occured in the easterly and southerly quadrants, storm reports being received from vessels as far south as the 35th parallel. The conditions changed but little during the next 24 hours, and the LOW remained nearly stationary. On the 27th there was also a slight depression near 35° N., 43° W., that afterwards developed into a severe disturbance, as it drifted slowly eastward. On the 30th it was central near 37° N., 37° W., and surrounded by moderate winds. On the 27th and 28th winds of moderate gale force were encountered off the coast of Northern Europe.

On the 28th and 29th there was a "norther" in the Gulf of Mexico, where winds of gale force prevailed, accompanied by comparatively high barometric readings.

On the 30th there was a LOW in the Gulf of Mexico that developed into a severe disturbance, as it moved northward along the American coast. An account of this storm will appear in the MONTHLY WEATHER REVIEW for December.

OCEAN GALES AND STORMS, NOVEMBER, 1925

Vessel	Voyage		Position at time of lowest barometer		Gale began	Time of lowest barometer	Gale ended	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Highest force of wind and direction	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
NORTH ATLANTIC OCEAN			° ′	° ′				*Inches*					
Duquesne, Am. S. S.	Manchester	New Orleans	50 04 N.	10 15 W.	1st	2 p., 1st	2d	29.07	SSE.	S., 9	SW.	S., 9	S.-WSW.
Westerner, Am. S. S.	Antwerp	Boston	40 18 N.	27 32 W.	1st	Noon, 2d	2d	29.58	SSW.	SSW., 9	NNW.	SW., 9	SW.-NNW.
Eastern Victor, Am. S. S.	Rotterdam	Philadelphia	36 34 N.	66 15 W.	3d	11p., 3d	5th	29.78	SE.	NE., 7	E.	N., 10	W.-NW.-NE.
Eibergen, Du. S. S.	Montreal	Rotterdam	52 36 N.	39 10 W.	2d	9p., 4th	5th	29.44	WNW.	W., 8	SW.	WSW., 10	W.-WSW.
H. M. Story, Am. S. S.	Cristobal	Halifax	23 53 N.	68 07 W.	4th	8a., 4th	5th	30.00	NNE.	NE., 5	NE.	NE., 11	NNE.-NE.
Davisian, Br. S. S.	Boston	Liverpool	48 00 N.	33 00 W.	5th	7p., 5th	8th	28.04	ESE.	S., 12	N.	S., 12	S.-SW.
City of Fairbury, Am. S. S.	Antwerp	Houston	30 00 N.	58 05 W.	5th	Noon, 5th	6th	29.74	NW.	NE., 9	NNE.	NNE., 9	NW.-NNE.
Gulfqueen, Am. S. S.	New Orleans	San Pedro	21 05 N.	85 00 W.	4th	5a., 6th	7th	29.92	E.	E., 8	E.	E., 8	Steady.
Marguerite Finaly, Fr. S. S.	Rouen	Bermuda	31 45 N.	58 20 W.	5th	5a.,7th	8th	29.73	NE.	NNE.	N.	NE., 9	NE.-N.
Haarlem, Du. S. S.	Amsterdam	Cristobal	47 20 N.	10 40 W.	6th	—, 7th	10th	29.00	SW.	SW., 10	WNW	W., 12	SSW.-W.
Incemore, Br. S. S.	Belfast	New York	55 13 N.	14 57 W.	6th	8a., 7th	9th	29.07	NW.	E., 10	NW.	NE., 10	SE.-E.
Westerner, Am. S. S.	Antwerp	Boston	39 30 N.	49 00 W.	7th	2a., 8th	8th	29.80	ENE.	ENE., 10	ENE.	ENE., 11	Steady.
Tegucigalpa, Hond. S. S.	Vera Cruz	New Orleans	20 00 N.	96 00 W.	9th	7p., 9th	10th	29.82	WNW.	WNW., 8	WNW.	WNW., 8	Do.
Incemore, Br. S. S.	Belfast	New York	50 41 N.	42 23 W.	11th	8a., 11th	12th	29.68	WNW.	NW., 8	W.	NW., 10	WNW.-NW.
City of St. Joseph, Am. S. S.	New York	Mediterranean.	38 01 N.	13 48 W.	10th	4a., 11th	11th	29.90	NNW.	NNE., 9	N.	NNW., 9	NNW.-NNE.
E. R. Kemp, Am. S. S.	Houston	Portsmouth, Va.	26 40 N.	88 15 W.	11th	10p., 11th	12th	29.75	S.	S.	S.	—, 8	S.-SW.
Siraois, Am. S. S.	New York	Kingston	34 48 N.	73 59 W.	12th	Mid., 12th	13th	29.61	SE.	SE., 10	W.	—, 10	
Atenas, Am. S. S.	New Orleans	Cristobal	27 54 N.	87 50 W.	12th	4a., 12th	12th	29.76	S.	S., 7	W.	SW., 8	S.-W.-N.
Columbia, Am. S. S.	Cristobal	New York	34 20 N.	75 55 W.	11th	Mid., 12th	13th	29.60	ENE.	SW., 9	SW.	SE., 9	S.-W.
United States, Dan. S. S.	New York	Christiansand.	40 47 N.	68 37 W.	13th	7a., 13th	14th	29.41	SE.	SE., 9	SSW.	SE., 9	SE.-SSW.
Albert Ballin, Ger. S. S.	Hamburg	New York	41 41 N.	64 00 W.	14th	6p., 14th	16th	29.27	WSW.	W., 9	NW.	W., 9	WSW.-W.
Laguna, Br. M. S.	Colon	Santander	40 18 N.	18 30 W.	14th	—, 14th	16th	29.57	SW.	NW., 7	N.	NW., 8	SE.-NW.
Virginia, Am. S. S.	Jacksonville	Port Arthur	22 22 N.	97 16 W.	15th	4a., 15th	16th	29.90	N.	N.	N.	N., 10	Steady.
El Oriente, Am. S. S.	New York	Galveston	36 00 N.	74 50 W.	15th	2p., 15th	16th	29.63	S.	S.	S.	S., 10	Do.
Hoosac, Br. S. S.	Halifax	Liverpool	47 54 N.	47 57 W.	15th	8 p., 15th	17th	29.19	WSW.	WSW.	N.	—, 11	WSW.-N.
Pres. Roosevelt, Am. S. S.	Cherbourg	New York	47 00 N.	38 20 W.	15th	Mid., 15th	16th	29.44	S.	SW., 8	NNW.	SSW., 10	SW.-WSW.
American Press, Am. S. S.	New Orleans	Glasgow	37 40 N.	67 53 W.	16th	1p., 16th	16th	29.71	S.	W., 10	NW.	W., 10	S.-W.
Rochambeau, Fr. S. S.	Havre	New York	49 30 N.	35 00 W.	16th	—, 16th	17th	29.34	S.	S., 10	N.	S., 12	
Parthenia, Br. S. S.	Montreal	Glasgow	56 03 N.	23 42 W.	16th	7a., 16th	16th	29.95	SW.	SSW., 10	SSW.	SSW., 10	SW.-SSW.
Patria, Fr. S. S.	Palermo	New York	36 57 N.	55 39 W.	17th	6p., 17th	19th	29.92	W.	W., 7	NW.	NNW., 10	W.-NNW.
Venezuela, Du. S. S.	Dover	Barbados	36 10 N.	35 20 W.	20th	4p., 20th	21st	29.82	WNW.	WNW., 7	WNW.	WNW., 8	Steady.
Atenas, Am. S. S.	Cristobal	New Orleans	16 06 N.	86 10 W.	22d	11a., 22d	22d	29.85	SW.	SW., 8	NW.	NW., 8	SW.-N.
Bennedijk, Du. S. S.	Rotterdam	New York	41 13 N.	65 07 W.	23d	11a., 23d	23d	29.21	SSE.	Calm	Calm	—, 10	SSE.-SW.
Sinsinawa, Am. S. S.	Valencia, Spain.	do	32 59 N.	38 03 W.	23d	Noon, 23d	24th	29.57	SE.	NW., 7	N.	N., 9	SE.-NW.-N.
Republic, Am. S. S.	New York	Cobh, Ireland.	42 00 N.	52 55 W.	23d	2a., 25th	25th	29.40	SSE.	S., 8	SW.	SE., 11	SE.-SW.
Suveric, Br. S. S.	Oran	Philadelphia	35 40 N.	50 39 W.	26th	1a., 27th	28th	29.85	SSW.	NW., 10	N.	NW., 10	SSW.-NW.-N.
American Press, Am. S. S.	New Orleans	Glasgow	55 18 N.	9 30 W.	28th	5a., 28th	28th	30.03	N.	NNW.	N.	NNW., 8	N.-NNW.
War Nizam, Br. S. S.	Curacao	Rotterdam	38 20 N.	37 06 W.	28th	4p., 30th	Dec., 2d	29.55	WNW.	NNW., 7	NW.	NW., 8	NNW.-N.
San Jacinto, Am. S. S.	Galveston	New York	25 25 N.	85 38 W.	29th	4p., 30th	Dec. 1st	29.66	NE.	NE., 8	WNW.	NE., 8	NE.-N.
NORTH PACIFIC OCEAN													
West Faralon, Am. S. S.	San Francisco	Yokohama	34 20 N.	143 E.	2d	2a., 3d	3d	29.51	NNW.	NE.	N.	NE., 8	Variable.
Pres. Madison, Am. S. S.	Seattle	do	51 38 N.	165 17 W.	1st	10 a., 3d	4th	29.02	NNW.	W., 8	W.	W., 10	SSE.-W.
Iyo Maru, Jap. S. S.	Victoria	do	52 N.	168 59 W.	4th	10 a., 5th	6th	28.53	SSE.	SSE., 7	SW.	SSE., 10	SSE.-SW.
India Arrow, Am. S. S.	Shanghai	San Francisco	41 12 N.	153 28 E.	5th	6 a.	5th	29.41	NW.	NW., 8	NNW.	NW., 8	NW.-NNW.

Ocean gales and storms, November, 1925—Continued

Vessel	Voyage From—	Voyage To—	Position at time of lowest barometer Latitude	Position at time of lowest barometer Longitude	Gale began	Time of lowest barometer	Gale ended	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Highest force of wind and direction	Shifts of wind near time of lowest barometer
NORTH PACIFIC OCEAN—Continued			° ′	° ′				*Inches*					
West Cayote, Am. S. S.	Japan	San Francisco	46 30 N.	171 40 E.	5th	7 p., 5th	7th	9.221	SSE.	SSE., 8	WNW.	W., 11	SSE.–SSW.–W.
Havre Maru, Jap. S. S.	do	Coos Bay	47 50 N.	138 18 W.	6th	6th	7th	29.09	NW.	SE., 8	W8W.	S., 11	SE.–WSW.
Tokiwa Maru, Jap. S. S.	Yokohama	Victoria	47 13 N.	170 10 E.	5th	4 a., 6th	8th	28.68	S	W., 11	W	W., 11	SW.–W.
Oakridge, Am. S. S.	Davao, P. I.	Columbia R.	45 53 N.	146 28 W.	5th	9 p., 9th	10th	29.10	SE.	W., 7	W	W., 11	WSW.–W.
West Prospect, Am. S. S.	Manila	San Francisco	42 N.	173 30 W.	5th	2 a., 5th	12th		SSE.	SSE., 10	W	W., 11	Steady.
Makena, Am. S. S.	Everett	Kahului	44 18 N.	131 32 W.	9th	4 a.	9th	29.55	SE.	SE., 8	SE.	SE., 8	Do.
Varanger, Nor. S. S.	San Pedro	Vancouver	48 02 N.	125 W.	8th	4 a., 9th	11th			NW., 11		NW., 11	
India Arrow, Am. S. S.	Shanghai	San Pedro	45 46 N.	147 47 W.	11th	3 p., 11th	15th	29.20	SSW.	NW., 8	NW	NW., 9	Do.
(An unknown S. S.)		Southward	17 N.	102 W.	10th	2 a., 11th	11th	[1]29.19	NE.	NW., 11	SW	NW., 11	
Iyo Maru, Jap. S. S.	Victoria	Yokohama	44 10 N.	155 30 E.	12th	8 p., 12th	13th	28.98	ESE.	SW., 12	W	SW., 12	SW.–W.
West Cayote, Am. S. S.	Japan	San Francisco	48 45 N.	138 15 W.	12th	3 a., 12th	13th	29.49	S	S., 8	S	S., 11	Steady.
Yokohama Maru, Jap. S. S.	Yokohama	Victoria	41 02 N.	153 42 E.	13th	Noon, 14th	15th	29.13	ESE.	NW., 8	NNW.	NW., 9	ESE.–S.–NNW.
West Himrod, Am. S. S.	Seattle	Kobe	48 10 N.	170 22 E.	13th	8 a., 13th	16th	29.31	SSE.	SSE., 8	SW	W8W., 11	SW.–WSW.
West Jessup, Am. S. S.	Davao, P. I.	Portland	40 09 N.	167 04 E.	14th	4 a., 15th	15th	29.66	SSW.	W., 10	NW	W., 10	WSW.–W.
Iwatesan Maru, Jap. S. S.	Yokohama	San Francisco	41 25 N.	155 35 E.	14th	2 p., 14th	15th	29.26	S	NW., 8	NNW.	NNW., 10	Variable.
Shenandoah, Am. S. S.	Los Angeles	Port Arthur	15 08 N.	97 27 W.	16th	5 p., 16th	17th	29.86	NNE.	N., 8	N	NW., 10	N.–NE.
Meiyo Maru, Jap. S. S.	Muroran	Vancouver	42 27 N.	149 35 E.	16th	6 a. 17th	17th	29.40	NW.	NW., 9	NNW.	NW., 9	NW.–WNW.
West Carmona, Am. S. S.	Hongkong	San Francisco	39 50 N.	159 26 W.	18th	6 a., 19th	19th	29.74	SSE.	S8W., 8	SW	S., 10	SSE.–S.–SW.
Grootendijk, Du. S. S.	Astoria	Balboa	14 30 N.	96 03 W.	22d	8 p., 22d	23d	29.76	NNE.	NNE., 8	N	NNE., 9	Steady.
Pres. Taft, Am. S. S.	San Francisco	Yokohama	25 06 N.	165 24 W.	22d	22d	23d	29.88	NNW.	NNW., 8	N	NNW., 8	SW.–NNW.
Albert Jeffreys, Am. S. S.	Norfolk	Los Angeles	13 50 N.	93 53 W.	22d	6 p., 22d	24th	29.85	NNW.	NNW., 8	NE	N., 9	
Emp. of Russia, Br. S. S.	Yokohama	Vancouver	48 52 N.	175 W.	25th	9 p.	25th	29.18	SE.	S8E., 9	WNW	S8E., 9	
Tsuyama Maru, Jap. S. S.	Otaru	San Francisco	47 05 N.	170 10 E.	25th	4 a., 26th	29th	28.92	W8W.	W8W., 7	W8W	S8E., 9	SW.–S.–SSE.
Tenyo Maru, Jap. S. S.	San Francisco	Yokohama	30 41 N.	141 30 W.	26th	Noon, 27th	28th	29.35	SSE.	SW., 8	NNE.	NW., 9	
Maui, Am. S. S.	Honolulu	San Francisco	30 N.	143 W.	27th	4 a., 28th	28th	29.58	NW.	NW., 7	NW	NW., 8	NW.–WNW.
Hokkai Maru, Jap. S. S.	Japan	Vancouver	50 10 N.	150 20 W.	28th	3 a., 28th	Dec. 3	29.46	S8W.	S	S8W	S., 10	S.–S8W.

[1] Uncorrected.

NORTH PACIFIC OCEAN

By WILLIS EDWIN HURD

After the rather unusual breaking down of the North Pacific anticyclone in October, the November observations show its fairly complete establishment over the central waters of the eastern part of the ocean. On the 23d, however, its center lay north of Midway Island, or well to the west of its normal position. At this time a small, shallow LOW developed east of the Hawaiian Islands. The LOW spread and moved northeast and by the 27th and 28th had covered the entire water area east of 150° W. and south of 50° N., except in the equatorial region, with moderate gales in the western quadrants. At the close of the month it had merged with the cyclone then covering Alaska and adjacent waters. The HIGH at the end of the month had moved to a position north of the Hawaiian Islands midway between the trough to the east and another cyclone of little-known intensity which had developed near Midway Island on the 29th.

The Aleutian cyclone was strongly developed during most of the month, and pressures were below normal from Juneau westward to the 180th meridian. In fact, no high-pressure readings occurred over the Aleutians and southwestern Alaska, and it was on only one or two days here that there were readings in excess of 30 inches. These conditions are well shown by the following table of atmospheric pressures for several island and coast stations:

Station	Average pressure	Departure from normal	Highest	Date	Lowest	Date
	Inches	*Inches*	*Inches*		*Inches*	
Dutch Harbor [1]	29.38	−0.21	30.04	23d	28.72	19th.
St. Paul [1]	29.44	−0.18	30.04	do	28.34	28th.
Kodiak [1]	29.33	−0.21	30.06	2d	28.62	10th.
Midway Island [1 2]	30.10	+0.03	30.30	22d	29.64	29th.
Honolulu [3]	30.03	0.00	30.12	14th	29.87	4th.
Juneau [3]	29.68	−0.08	30.34	20th	29.02	10th.
Tatoosh Island [3 4]	30.02	+0.05	30.62	do	29.40	Do.
San Francisco [3 4]	30.13	+0.03	30.46	14th	29.87	23d.
San Diego [3 4]	30.05	+0.05	30.28	do	29.83	Do.

[1] P. m. observations only.
[2] 28 days.
[3] A. m. and p. m. observations.
[4] Corrected to 24-hour mean.

November was one of the three stormy months thus far occurring in 1925. Along the northern steamer routes, or, roughly, between the 40th and 53d parallels, gales of force 8 or over occurred somewhere daily and, as gathered from the various reports, gales of force 11 to 12 were experienced by vessels on eight days. These were the 6th, 9th, 11th, 12th, 13th, 15th, 20th, and 28th. The 6th, perhaps, showed the most widespread area of tempestuous winds, since gales of force 11 were reported on that day from near 47° N., 177° E., 46° N., 165° W., and 48° N., 138° W., in addition to gales of lesser severity in other parts of the sea. On the 13th whole gales to storm winds occurred over a considerable area in east and west longitudes. On the 12th occurred the only hurricane velocity recorded, that being noted in 44° 10′ N., 155° 30′ E., by the Japanese steamer *Iyo Maru*. The American steamer *West Prospect*, while on a voyage from Manila to San Francisco, encountered gales, highest force 11, from the 5th to the 12th, between 175° W. and 135° W., nearly along the 42d parallel. Snow and other forms of frozen precipitation occurred over the northernmost traveled routes on several days.

At Honolulu east winds continued to prevail. The maximum wind velocity was 31 miles from the northeast, on the 27th. The average velocity was 10.1 miles per hour, which equals the previous highest record for November, that of 1913. The precipitation was 1.35 inches, which is 2.49 below the normal.

In the Far East there was some typhoon activity early in the month. This is fully treated in the accompanying article by the Rev. José Coronas, of the Manila Observatory.

In North American tropical waters a case of cyclonic development occurred, which is extraordinary for so late in the season. This disturbance appeared on the 10th off the coast near Acapulco, where it was experienced by a southbound vessel, whose identity was not given by the observer. The gale as experienced began from the east early on the evening of the 10th, and by midnight, in 17° N., 102° W., was blowing at force 10 from the north. Two hours later the wind had gone into northwest, force 11, lowest pressure 29.19, uncorrected. By 8 a. m. of the 11th the wind had moderated to force 7, southwest.

while the pressure had risen to 29.72. On the morning of the 11th the storm lay off Manzanillo, where it gave locally heavy rains to some of the coast towns, but no later report concerning it is yet available. It is interesting to note in connection with this storm that a disturbance appeared over the northwestern part of the Gulf of Mexico on the afternoon of the 12th.

On the 15th a northeast gale of force 8 was experienced by the British steamer *Toco*, in 17° 15′ N., 107° W., accompanied by only a slight depression of the barometer. On the 16th, 17th, 22d, and 23d gales of force 8 to 10 occurred over and south of the Gulf of Tehuantepec, but these were not accompanied by barometric disturbances. Observers of the whole northeast gales of the 16th and 17th report that they began and ended suddenly, their onset being accompanied by heavy rain squalls, which shortly cleared, so that generally fair weather prevailed during the remainder of the blow.

Fog was little observed in west longitudes this month, except along the American coast north of the 30th parallel. West of the 180th meridian scattered observances of fog were recorded on eight days.

WATERSPOUT ON THE SOUTH PACIFIC OCEAN

Mr. J. V. Bray, second officer of the British motor ship *Aorangi*, Capt. R. Crawford, Sydney, Australia, toward Honolulu, gives the following account of a waterspout observed November 1, 1925, in 5° 42′ S., 172° 39′ W.:

When first observed at 7 a. m. by senior second and fourth officers, waterspout appeared descending from a white cumulus cloud and revolving in a counterclockwise direction. The phenomenon disappeared about 20 minutes after first observed, and about half way down during descent the spout could be plainly seen to take a sharp turn almost at right angles, curving around a small cumulus cloud underneath; also spray, distinctly white, to be seen rushing up the spout. When abeam it lifted and disappeared. The whole aspect was white—ascending spray and descending cloud. The clouds were of a clearly defined cumulus type. Other observers state that before final descent the spout thinned and could be seen through. Distance of spout, 2½ miles; estimated height, 3,000 feet. Sky clear, one-fifth clouded by tumulus. Wind ENE. 1. Temperature 83°.—*W. E. H.*

TWO TYPHOONS OVER THE PACIFIC AND ONE DEPRESSION OVER THE PHILIPPINES IN NOVEMBER, 1925

By Rev. José Coronas, S. J.

[Weather Bureau, Manila, P. I.]

The first Pacific typhoon had appeared already in our weather maps, on the 24th of the last month of October, near 145° or 146° longitude E. and 9° latitude N. It moved first WNW., passing about 100 miles to the north of Yap in the afternoon of the 27th. On the 28th it began to move northwestward about 600 miles to the east of north Samar. The steamer *Comliebank*, on her way from San Francisco to Manila, was well under the influence of this typhoon on the 28th and 29th. On October 31, when the center was east of Balintang Channel near 127° longitude E. and 20° latitude N., there was a decided change of the direction to the N. and N. by E., the center being situated at 6 a. m. of November 1 to the south of Naha in about 25° latitude N. between 127° and 128° longitude E.; the barometric minimum in Naha was then 745.5 mm. (29.35 ins.) with strong winds from NE. The typhoon finished its recurving to ENE. on November 1, and filled up on the 2d between Japan and the Bonins.

The second Pacific typhoon was shown by our weather maps on October 31 over the western Carolines near 150° longitude E. and 8° latitude N. It moved NNW. on October 31, NW. and WNW. on November 1, and recurved to the N. and NE. on November 2 and 3. The center of the typhoon passed about 100 miles to the north of Yap in the afternoon of November 1. The recurving to the north took place near 138° longitude E. and 19° latitude N. Our maps showed the center to the southeast of the Bonins at 6 a. m. of the 4th near 145° longitude E. and 24° latitude N. moving NE. or NE. by E.

The depression which traversed the Philippines on the 9th of November appeared at 6 a. m. of the 6th to the SSE. of Yap near 140° longitude E. and 5° latitude N. After moving practically WNW. for over two days, it crossed the Visayan Islands on the 9th with an almost due west direction and an extraordinary rate of progress of nearly 19 miles per hour. The center reached the southern part of Indochina in the early morning of November 11.

ADDITIONAL NOTE ON TROPICAL CYCLONE OF OCTOBER 22–25, 1925, OFF WEST COAST OF MEXICO

By Charles C. Allen

[Weather Bureau Office, San Francisco, Calif., December 22, 1925]

During the latter part of October, 1925, a tropical storm of violent character appeared off the west coast of Mexico to the south of latitude 20° N., moving in a direction along the Panama-San Francisco steamer route until it turned inland near Cape Corrientes on the 24th–25th.

This disturbance, which has already been referred to in the Monthly Weather Review, for October, overtook several steamers in its progress along the coast. Capt. J. A. Mordue, of the British steamer *Kathlamba* has furnished a detailed and interesting report of his encounter with this cyclone.

On the night of October 22–23 it became evident that a storm from the south was overtaking the *Kathlamba*, the wind having changed during the night from light and variable to fresh easterly, accompanied by squalls. The barometer remained steady at 29.78 inches until noon of the 23d, after which hour the pressure fell steadily, and after 8 a. m. of the 24th quite rapidly (from 29.60 ins. at 8 a. m. to 28.57 ins. at noon), with the wind backing to the northeast and north, increasing to force 12. As the backing of the wind indicated that the center of the storm was moving upon the ship quite swiftly, and even then swerving to the eastward, Captain Mordue altered his course to the westward in hope of escaping the full violence of the storm. He succeeded in that one particular, but nevertheless experienced wind and sea of great fury. His own words tell graphically of the situation at the height of the storm, when in an estimated position at noon, October 24, of latitude 18° 53′ N., and longitude 106° 05′ W. At that time the wind was north, force 12, and the lowest pressure reading was 28.57 inches. His description, in part, reads:

During this time the wind was sweeping overhead. Canvas weather screens and dodgers and light awnings over the bridge and poop were torn from their fastenings and whirled away to leeward. One of the starboard boats was blown adrift from its chocks, and some idea of the force of the wind can be formed from the fact that the pressure on the steam whistle lanyard was sufficient to cause the whistle to sound full blast at frequent intervals.

The ship was swept by a continuous blinding smother of rain and spray through which the dim loom of the white painted foremast could just be discerned from the bridge—the limit of our vision forward, the forecastle head and all on it being completely obliterated.

After 1.30 p. m. (October 24) the barometer commenced to rise, although the wind held steady from the northwest for several hours, gradually falling to moderate westerly by the morning of the 25th.

The S. S. *City of Stockholm*, bound north and about 120 miles northwest by west of the *Kathlamba*, experienced very little of the hurricane's fury.

That part of Mexico in the path of the storm had rainfall on the 24th–25th, which was quite heavy at some coastal points.

DETAILS OF THE WEATHER IN THE UNITED STATES

GENERAL CONDITIONS

The month may be described as moderately cool and generally wet. An increase in the intensity of the general circulation was noticeable especially in the second decade when several deep barometric depressions moved from the Gulf of Mexico to the St. Lawrence Valley. An anticyclone that passed Midway Island in the Pacific on the 10th could be traced across the Pacific, the North American continent, and part of the Atlantic, where it merged with prevailing high pressure in that region on the 19th, after having traversed about one-third of the circumference of the globe.—*A. J. H.*

CYCLONES AND ANTICYCLONES

By W. P. DAY

Eighteen low-pressure areas were plotted, of which seven were of the Alberta type. The tracks of these seven were generally so far to the north that they had little direct effect on the weather in the United States and much of the real weather of the month was due to secondaries which formed over the Southwest. In fact, most of the Alberta LOWS were well shown at Fort Simpson, in the Mackenzie Valley before being picked up again along the line of Canadian stations; and pressure was continually below normal in Alaska and the Mackenzie Basin for about 12 days during the middle of the month. Several important storms developed over the Southwest and reached considerable intensity over the Lake region and the Northeastern States. On the last day of the month a tropical storm developed northwest of Cuba, crossed the Florida Peninsula with increasing intensity, reaching hurricane proportions off the northeast Florida coast and striking the coast again between Wilmington and Hatteras.

The more marked of the temperature depressions were due to Alberta HIGHS. These HIGHS were well shown at Fort Simpson and to some extent at Eagle, Alaska.

FREE-AIR SUMMARY

By L. T. SAMUELS

Free-air temperatures for the month averaged for the most part slightly below normal (Table 1). While the monthly departures did not vary greatly with increase in altitude, those for the upper levels at the northern and southern stations stand in rather marked contrast, being negative at the former and positive at the latter. Notwithstanding this deficiency in mean temperature, the relative humidities averaged generally below normal. This naturally resulted in negative departures in the mean vapor pressures for the month.

It will be seen in Table 2 that the resultant winds for the month based on kite observations differed but little from their normals. Those indicated by afternoon pilot-balloon observations, having been determined from a greater number of stations, show a pronounced westerly drift at the 3 km. level at all stations, including Key West.

Pilot-balloon observations from the 18th to the 21st showed a decidedly abnormal drift in the general circulation for this season. During this time practically the entire country was covered by a pronounced anticyclone which had moved inland over the North Pacific States and gradually spread southward and eastward until by the end of the period its southern border had invaded the tropics. This resulted in relatively low temperatures over an extended area in the lower latitudes, whereas low pressure attended by relatively high temperatures prevailed over the Canadian Provinces. The free-air temperature distribution during this period is strikingly shown in a comparison of the kite observations made at the four western aerological stations. These temperatures (°C.) are given in the following table, wherein the stations are arranged geographically.

Station	Date	Altitude (m.) m. s. l.				
		1,000	2,000	3,000	4,000	5,000
Ellendale	18	4.3	−1.8	−10.0		
Drexel	18	7.3	−0.7	−7.1		
Broken Arrow	18	9.6	2.8	−0.7		
Groesbeck	18	14.1	8.3	1.8		
Ellendale	19	5.9	1.7	−4.0	−8.3	−13.6
Drexel	19	3.9	−2.4	−7.0		
Broken Arrow	19	6.5	0.5	−6.8	−10.0	
Groesbeck	19	10.8	4.6			
Ellendale	20	12.4	7.6	2.9		
Drexel	20	9.8	6.7	2.1		
Broken Arrow	20	6.9				
Groesbeck	20	7.4	3.2			
Ellendale	21	−1.2	−5.7			
Drexel	21	11.6	5.0	−0.3		
Broken Arrow	21	9.8	6.0	1.0		
Groesbeck	21					

It is evident that the temperature reversal was most pronounced on the 20th, when it was 4.2° C. colder at 2,000 m. above the Texas station than at the same elevation over Ellendale, situated in the extreme northern part of the country.

The effect of this condition was temporarily to reverse the general pressure gradient aloft and thereby cause easterly winds in the upper levels. Some of those observed by pilot-balloon observations are shown in the following table.

Station	Date	Altitude (m.) m. s. l.								
		2,000	3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000
Broken Arrow	19	nnw. 14	n. 11	nne. 10	ne. 16	nne. 14				
Do	20	w. 3	w. 3	sw. 4	e. 4	ese. 4	ene. 8			
Do	21	wsw. 10	wsw. 8	s. 4	ene. 6					
Denver	18	e. 6	ne. 4							
Do	19	ssw. 2	n. 6	nne. 6	ne. 8	ne. 11	ene. 10	ene. 15	ne. 16	
Do	20	sse. 3	nw. 2	nnw. 2	nw. 2	wnw. 2	w. 1	nnw. 2	wnw. 2	se. 1
Do	21	nne. 3								
Drexel	19	nnw. 12	n. 12	n. 14	nne. 19	nne. 22				
Due West	21	nne. 6	nne. 1	nne. 3	n. 4	nw. 6	wnw. 6	w. 8	w. 8	w. 23
Groesbeck	20	nne. 11	ese. 8	wnw. 6	wnw. 11	wnw. 19	w. 28	w. 32	w. 35	w. 39
Washington	20	nw. 8	n. 8	nne. 10						

Several unusually pronounced temperature inversions and isothermal conditions were observed during the month. One of the latter occurred at Royal Center on

the 3d in the rear of a deep anticyclone which had spread southward from the Hudson Bay region. The temperatures at the ground and at 2370 m. above were identical, the greatest variation throughout this air column being less than 3.0° C. and the wind southeasterly. On the next day (4th), this station still being under the influence of the HIGH, the lapse rate remained practically the same to this height, except that the temperatures were slightly higher throughout, the winds having changed to southerly and south-southwesterly. The lapse rates in the front sector of this HIGH as shown by airplane and kite observations at Washington and Due West, respectively, were characterized by a decrease in temperature from the ground to about 1,500 m., followed by a pronounced inversion to about 2,000 m., above which, to 3,000 m., the lapse rate was small. When these latter stations were later under the influence of the rear sector, an isothermal layer extended to the same height as had previously been observed at Royal Center under similar conditions.

Another exceedingly pronounced inversion, or rather double inversion, was observed at Groesbeck when a rapidly moving anticyclone passed over that station on the 8th. At the maximum altitude (2,612 m., m. s. l.), the temperature was 3.2° C. higher than at the surface. The vertical temperature gradients (°C. per 100 m.) shown by the kite observations are given in the following table.

Surface.	141 m.	604 m.	1,014 m.	1,501 m.	2,134 m.	2,612 m.
	0.82	−1.73	0.53	−0.60	0.25	

An excellent example of the well-known Brocken specter was observed during the airplane flight at Washington on the 6th. After the plane had surmounted a layer of St Cu, the base of which lay at 1,380 m. and the tops at 1,650 m., "the shadow of the plane on the clouds was surrounded by a brilliant double-colored ring, with the interior of the inner ring much brightened. The rings faded out as the plane ascended but remained visible long after the shadow of the plane had dwindled to nothing." The phenomenon was again plainly seen when descending from the maximum altitude to the top of the cloud layer.

A very marked surface of discontinuity was shown by the kite record at Ellendale on the 8th. In the NW. quadrant of an anticyclone the southerly winds of the lower levels shifted to northwesterly at 2,200 m. From the ground to this height the relative humidity was high, there being a layer of St clouds at 1,300 m. and occasional snow flurries. At the upper limit of the clouds (2,200 m.) a pronounced inversion (−3.36 °C. per 100 m.) prevailed throughout a 100 m. air column and the relative humidity dropped abruptly to 7 per cent and continued close to this value to at least 3,500 m., the maximum altitude reached. This very dry condition in the upper levels of the second quadrant of an anticyclone is in agreement with results obtained in a recent study of the average free-air conditions in HIGHS and LOWS for this country.

TABLE 1.—*Free-air temperature, relative humidities, and vapor pressure during November, 1925*

TEMPERATURE (°C.)

Altitude m. s. l. (meters)	Broken Arrow, Okla. (233 meters)		Drexel, Nebr. (396 meters)		Due West, S. C. (217 meters)		Ellendale, N. Dak. (444 meters)		Groesbeck, Tex. (141 meters)		Royal Center, Ind. (225 meters)	
	Mean	Departure from 8-yr. mean	Mean	Departure from 11-yr. mean	Mean	Departure from 5-yr. mean	Mean	Departure from 8-yr. mean	Mean	Departure from 8-yr. mean	Mean	Departure from 8-yr. mean
Surface	7.9	−2.0	2.4	−1.1	9.1	−1.9	−1.6	+0.2	12.5	−0.5	2.6	−2.0
250	7.9	−1.9			8.9	−1.9			12.2	−0.6	2.4	−2.0
500	8.2	−0.8	2.6	−0.8	7.9	−1.9	−1.3	+0.5	11.8	−0.5	1.1	−1.9
750	8.4	+0.1	3.1	0.0	7.1	−1.7	−0.4	+1.2	11.6	−0.1	0.5	−1.7
1,000	8.2	+0.5	3.2	+0.2	6.2	−1.8	−1.1	+0.3	11.6	+0.4	0.1	−1.4
1,250	7.4	+0.3	2.8	0.0	5.4	−1.9	−1.6	−0.2	11.1	+0.7	−0.5	−1.4
1,500	6.3	−0.1	1.9	−0.3	5.2	−1.4	−2.0	−0.3	10.6	+1.0	−1.4	−1.7
2,000	4.4	−0.1	−0.4	−0.8	3.8	−1.2	−3.8	−0.6	9.2	+1.5	−3.2	−1.8
2,500	1.9	−0.4	−3.6	−1.1	2.7	−0.5	−6.2	−0.8	7.0	+1.3	−5.1	−1.8
3,000	−1.0	−0.9	−5.3	−0.8	1.7	+0.9	−9.3	−1.3	4.0	+0.8	−7.4	−1.9
3,500	−4.0	−1.4	−4.2	−1.0	0.2	+2.1	−11.8	−1.0			−10.0	−2.3
4,000	−6.3	−1.3	−11.3	−1.3	−2.0	+2.7	−14.4	−0.7			−13.0	−2.3
4,500			−13.8	−1.1			−17.6	−1.1			−15.7	−2.3
5,000			−16.7	−1.1			−20.0	−1.1			−19.1	−2.8

RELATIVE HUMIDITY (%)

Surface	67	+1	68	−3	67	−1	75	−3	75	0	72	−1
250	66	0			66	−1			72	0	72	−1
50	58	−4	64	−4	59	−4	72	−4	62	−4	71	−1
750	53	−6	57	−6	56	−4	65	−5	51	−10	71	+1
1,000	48	−8	52	−6	55	−3	63	−2	42	−15	67	+1
1,250	46	−7	50	−5	53	−3	60	−1	40	−14	62	0
1,500	45	−5	49	−4	46	−7	57	−1	38	−13	59	+1
2,000	41	−5	47	−3	34	−12	54	0	34	−12	50	−3
2,500	37	−6	45	−4	16	−24	52	−1	32	−9	45	−4
3,000	37	−5	46	−4	24	−15	54	+1	36	−2	44	−3
3,500	38	−1	46	−5	15	−24	56	+2			42	−3
4,000	31	−2	47	−4	12	−26	65	+8			42	−1
4,500			46	−3			69	+10			41	−1
5,000			44	−3			50	0			43	−1

VAPOR PRESSURE (mb.)

Surface	7.10	−0.96	5.01	−0.72	8.31	−0.86	4.13	−0.29	11.73	−0.07	5.41	−1.04
250	7.04	−0.96			8.10	−0.90			11.04	−0.29	5.40	−0.98
500	6.30	−0.94	4.81	−0.68	6.72	−1.17	4.07	−0.27	9.40	−0.75	4.94	−0.76
750	5.70	−0.91	4.37	−0.60	6.12	−0.96	3.84	−0.19	7.83	−1.22	4.70	−0.47
1,000	5.03	−1.06	4.01	−0.55	5.60	−0.89	3.45	−0.27	6.58	−1.55	4.28	−0.33
1,250	4.56	−1.00	3.71	−0.54	4.99	−0.83	3.18	−0.27	6.03	−1.21	3.62	−0.45
1,500	4.18	−0.83	3.37	−0.56	4.12	−1.04	2.96	−0.23	5.46	−1.00	3.17	−0.45
2,000	3.27	−0.72	2.71	−0.53	2.31	−1.51	2.44	−0.25	4.41	−0.58	2.16	−0.74
2,500	2.44	−0.72	2.07	−0.64	0.39	−2.47	2.00	−0.27	3.71	−0.04	1.58	−0.70
3,000	1.96	−0.61	1.72	−0.57	0.76	−1.53	1.61	−0.26	3.30	+0.53	1.19	−0.79
3,500	1.52	−0.42	1.39	−0.51			1.39	−0.14			0.94	−0.60
4,000	1.11	−0.23	1.06	−0.50			1.23	−0.05			0.58	−0.42
4,500			0.77	−0.44			0.87	−0.27			0.26	−0.42
5,000			0.55	−0.38			0.25	−0.58			0.08	−0.49

TABLE 2.—*Free-air resultant winds (m. p. s.) during November 1925*

Altitude m. s. l. (meters)	Broken Arrow, Okla. (233 meters)				Drexel, Nebr. (396 meters)				Due West, S. C. (217 meters)				Ellendale, N. Dak. (444 meters)				Groesbeck, Tex. (141 meters)				Royal Center, Ind. (225 meters)			
	Mean		8-year mean		Mean		11-year mean		Mean		5-year mean		Mean		8-year mean		Mean		8-year mean		Mean		8-year mean	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Surface	S. 26°W.	2.6	S. 42°W.	1.5	S. 51°W.	1.4	S. 78°W.	1.4	N. 24°W.	0.8	N. 63°W.	0.7	N. 62°W.	2.7	N. 54°W.	2.4	S. 21°E.	0.3	N. 66°E.	0.2	S. 59°W.	2.7	S. 49°W.	2.0
250	S. 28°W.	2.5	S. 41°W.	1.5					N. 28°W.	0.8	N. 63°W.	0.7					S. 33°E.	0.8	S. 57°W.	0.5	S. 55°W.	3.0	S. 54°W.	2.7
500	S. 45°W.	4.4	S. 35°W.	2.6	S. 61°W.	2.4	S. 82°W.	2.1	N. 34°W.	0.8	N. 31°W.	1.3	N. 64°W.	3.0	N. 64°W.	2.6	S. 21°E.	2.2	S. 9°E.	1.3	S. 69°W.	6.8	S. 60°W.	5.0
750	S. 55°W.	5.4	S. 40°W.	3.3	S. 80°W.	3.8	W.	3.7	N. 69°W.	1.4	N. 81°W.	1.9	N. 63°W.	4.6	N. 64°W.	4.1	S. 15°W.	2.3	S. 21°W.	1.9	S. 68°W.	8.0	S. 64°W.	6.4
1,000	S. 62°W.	6.0	S. 52°W.	3.9	N. 88°W.	5.0	N. 89°W.	5.1	N. 81°W.	2.3	N. 86°W.	2.6	N. 61°W.	5.6	N. 66°W.	5.0	S. 27°W.	3.3	S. 40°W.	2.6	S. 81°W.	8.8	S. 73°W.	7.2
1,250	S. 70°W.	6.1	S. 60°W.	4.7	N. 84°W.	5.9	N. 86°W.	6.0	N. 74°W.	3.6	N. 84°W.	3.9	N. 63°W.	6.6	N. 69°W.	5.9	S. 44°W.	3.6	S. 56°W.	3.3	S. 75°W.	5.7	S. 75°W.	7.4
1,500	S. 80°W.	6.1	S. 68°W.	5.4	N. 77°W.	7.1	N. 85°W.	7.0	N. 79°W.	4.8	N. 86°W.	5.2	N. 66°W.	7.2	N. 65°W.	7.1	S. 68°W.	4.2	S. 67°W.	3.9	S. 85°W.	10.4	S. 79°W.	8.7
2,000	S. 85°W.	7.1	S. 75°W.	6.7	N. 70°W.	10.0	N. 81°W.	8.4	S. 87°W.	7.0	S. 88°W.	7.4	N. 71°W.	9.8	N. 66°W.	8.9	N. 87°W.	5.2	S. 81°W.	5.2	S. 85°W.	11.8	S. 83°W.	10.1
2,500	S. 88°W.	8.4	S. 81°W.	7.5	N. 70°W.	10.9	N. 79°W.	10.1	N. 79°W.	9.1	S. 87°W.	8.9	N. 66°W.	11.4	N. 68°W.	11.0	S. 86°W.	6.6	S. 85°W.	6.9	S. 84°W.	13.5	S. 85°W.	11.7
3,000	N. 79°W.	8.9	S. 82°W.	8.6	N. 73°W.	11.7	N. 79°W.	11.2	S. 56°W.	14.3	S. 84°W	10.1	N. 70°W.	12.2	N. 69°W.	12.8	S. 79°W.	10.9	S. 85°W.	8.6	S. 87°W.	14.9	N. 88°W.	13.1
3,500	N. 78°W.	9.4	S. 83°W.	9.2	N. 83°W	15.9	N. 77°W.	12.4	S. 22°W.	11.0	S. 84°W.	11.7	N. 67°W.	14.0	N. 67°W.	13.6	S. 73°W.	11.7	S. 75°W.	10.5	N. 78°W.	16.5	N. 84°W.	13.0
4,000	N. 83°W.	7.4	S. 84°W.	10.5	N. 80°W	11.9	N. 81°W.	13.4	S. 45°W.	12.0	S. 86°W.	13.4	N. 76°W.	14.1	N. 67°W.	13.3					N. 82°W.	17.2	W.	12.6
4,500	N. 68°W.	19.2	N. 83°W.	10.2	N. 83°W.	8.9	N. 85°W.	13.5	S. 45°W.	12.0	S. 86°W.	14.2	N. 66°W.	11.5	N. 61°W.	15.4					S. 87°W.	16.9	S. 84°W.	13.0
5,000					S. 85°W.	10.7	N. 82°W.	12.7					N. 22°W.	20.0	N. 70°W.	11.6					W.	20.0	W.	20.0

THE WEATHER ELEMENTS

By P. C. DAY, In Charge of Division

PRESSURE AND WINDS

Following a record-breaking month in many weather particulars, November, 1925, assumed more nearly the conditions expected in the last month of autumn, and, except in a few instances, was uneventful from a meteorological standpoint.

Cyclonic activity was confined mainly to the first half of the month, while anticyclones were in evidence during much of the latter half.

The month opened with an area of precipitation over the East Gulf and South Atlantic States, and as this moved northeastward heavy rains prevailed over limited areas near the coast from Georgia to Virginia. By the morning of the 4th a cyclone had advanced into the middle Plains, and, moving northeastward to Lake Superior, brought general rains to most of the central valleys, with some unusually heavy falls in east Texas. Immediately following this another cyclone overspread the territory somewhat south of that preceding, and it, too, moved northeastward, attended by general precipitation over nearly all central and eastern districts, heavy rains falling over portions of the Ohio and lower Mississippi Valleys, and local light snows in portions of the upper Lake region.

The third important cyclone developed off the middle Gulf coast during the 11th and by the morning of the 12th was central over northern Alabama, whence it moved to the lower lakes and northeastward during the following two days, as a severe storm attended by widespread and locally heavy rains over all sections from the Mississippi River eastward, and by high winds along the coast from Chesapeake Bay northward. A fourth cyclone was forming over the Southwest as this moved into the lower St. Lawrence Valley and by the middle of the month had advanced to the Ohio Valley, whence it moved northeastward. This, too, was attended by precipitation over much of the country from the Mississippi River eastward, though the amounts were generally less than fell in the preceding storm, except over portions of New England. Light snow fell in connection with this storm over much of the Lake region, Ohio Valley, and into New England.

The remainder of the month was without important cyclonic storms until about the 26th, when low pressure overspread northeastern Texas and during the following two days moved to New England, attended by precipitation over much of the country from the Mississippi Valley eastward.

As the month closed, a tropical storm passing over the Florida Peninsula gave some of the heaviest rains ever known over the more southern portions. At Miami a total fall of more than 15 inches occurred, 14.10 inches falling in 14 hours. A more extensive description of this storm will appear in the December issue of this REVIEW.

Anticyclones were confined mainly to western and northern districts during the first half of the month, but thereafter they were the dominant feature and extended into all portions, several reaching well into the South.

The monthly averages of pressure were highest over the middle and northern plateau, with a secondary high area over the Southeastern States, and they were above normal in all parts, save for a narrow area from Lake Superior to eastern Montana. Over southern Canada the average pressures were mainly below normal and this condition probably extended into the northern districts and over Alaska as well.

The surface winds attending the frequent cyclones were occasionally high, particularly about the 13th and 14th along the North Atlantic coast and in the lower Lake region; elsewhere high winds were mainly local and the far West was unusually free from severe storms for a late fall month.

The details of the more important wind and other storms appear at the end of this section.

TEMPERATURE

Important changes in temperature were rather frequent due to rapid pressure variations, but on the whole there were no great extremes, and the monthly averages were mainly not far from normal. A moderately cold area covered the Southeastern States and it was cooler than normal in all other districts from the Mississippi Valley eastward, save along the northern border, over much of New England and in southern Florida. It was cooler than normal also over the plateau region and portions of the southern Plains.

Average temperatures were above normal on the Pacific coast, along the entire northern border, over much of New England, and from the middle Plains northward into Canada, the departures increasing toward the north where in portions of the Northwest Provinces, the month was decidedly warm with the probability that this condition extended far to the northward and into Alaska

where press and other reports indicate the persistence of unusual warmth.

The warmest periods were about the first over the districts from the Rocky Mountains westward, from the 5th to 7th in the Ohio Valley and to the southward and southeastward, and near the end of the second decade over most northern districts.

The coldest periods were from the 6th to 9th over the Missouri, middle Mississippi, and lower Ohio Valleys, from the 22d to 24th over the lower Mississippi Valley and eastward, and from the 28th to 30th from the Great Lakes eastward. West of the Rocky Mountains they were scattered through the month, depending frequently upon the opportunities for high night radiation.

The lowest temperature reported was 21° below zero in the mountains of Colorado and temperatures nearly as low were observed in northern New England.

East of the Rocky Mountains temperatures below zero were observed as far south as Missouri, and freezing weather occurred at some point during the month in all the States.

PRECIPITATION

From the Rocky Mountains eastward the bulk of the precipitation occurred during the first half of the month, and over a large area from the southern Plains northeastward to the lower Lakes, and eastward nearly to the Atlantic coast the amounts were generous and mainly well above the normal, particularly over portions of northern Louisiana and near-by areas in Texas, and over western and southeastern Florida.

From the upper Lakes westward to and including the Missouri Valley, over the plateau and Pacific coast States, and from central Texas westward, except in portions of southern California, the precipitation was less than normal and materially so in portions of northern California and the far Northwest.

The moderately heavy rains in the western portion of the Carolinas and near-by areas, where severe drought existed in the late summer and early fall months, greatly improved the water supply, though the total fall for the year is still far short of the normal. At points in Florida the monthly totals were the greatest of record for November, notably at Miami, where the fall for a single 24 hours at the end of the month exceeded the entire fall of any previous November.

SNOWFALL

Following a month of unusually early, heavy and widely distributed snowfall, the amounts for November were frequently comparatively small and the territory covered considerably less extensive.

From the Rocky Mountains eastward the amounts were mainly small and confined principally to the northern half. Maximum depths ranged up to 12 inches at points in the upper Lake region and to two feet in extreme northern Maine. Elsewhere the totals were mainly only a few inches, although locally in eastern Iowa and western Illinois the falls were the heaviest of record for November, and there were local heavy falls in northern Kansas and eastern Colorado. West of the Rocky Mountains the total snowfall was mainly greater than in October, particularly over the northern districts and in the mountains of central California, though here the amounts were mainly light and less than normal.

By the end of the month the ground was free of snow except in extreme northern New England, over the upper Lake region and westward to the Dakotas, and at some of the high elevations of the western mountains.

RELATIVE HUMIDITY

This element had percentages above normal, though not materially so, over much of the country, the chief exceptions being portions of the Atlantic coast States, from the upper Lakes westward to the Rocky Mountains, and from Texas to California, where the percentages were somewhat less than normal.

SEVERE LOCAL HAIL AND WIND STORMS, NOVEMBER, 1925

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A more complete statement will appear in the annual report of the Chief of Bureau]

Place	Date	Time	Width of path, yards	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Whitefish Point, Mich. (10 miles north of).	5–6					Gale	Tow barge foundered in Lake Superior	Official, U. S. Weather Bureau.
Palestine, Tex	7	A. m				Thunderstorm	A few trees, telegraph and telephone poles blown down; plate glass windows broken.	Do.
Wilson County, Tenn. (central part of).	7	6:30 p. m.	200		$10,500	Small tornado	Heavy loss of livestock; some crop and property damage over path 10 miles long.	Do.
Canastota, N. Y	7				100,000	High wind	Main building of the Douglass Pectin Co., wrecked.	Do.
Syracuse, N. Y	7					High wind	Trees, signs, and roofs damaged	Do.
Polk and Marion Counties, Oreg.	11	A. m				Small tornado	Damage to a few buildings and trees over path about 5 miles long.	Do.
Buffalo, N. Y	15			4		Severe wind	Considerable damage to signs and windows; three barges wrecked off Buffalo harbor.	Do.
Philadelphia, Pa	16					Squall	Floating grain elevator capsized in Delaware River. Tug caught under it sunk; crew rescued.	Daily News (New York, N. Y.).
Yonkers, N. Y	16					Wind	High wall blown down wrecking garage and auto. Several persons injured.	Herald Tribune (New York, N. Y.).
Lexington, Mich. (near)	22			1		Squall	A man in small boat swept out into Lake Huron.	Official, U. S. Weather Bureau.
Blytheville, Ark	26	2:30 p. m.	33		$4,000	Small tornado	Some small buildings destroyed. Path 10 miles long.	Do.
Charlotte, Tenn. (near)	26	5 p. m			5,400	do	Property damage over path 6 miles long; 3 persons injured.	Do.
Bee Branch, Ark	26	5.30 p. m.				Heavy hail	Very large stones; windows broken in places	Do.
Florida	30			4		Tropical disturbance.	Much damage in various sections by wind and rain; public utilities hampered; a number of persons injured. Storm continued into December.	Official, U. S. Weather Bureau; Tribune (Tampa, Fla.); Telegraph (Tampa, Fla.).

STORMS AND WEATHER WARNINGS

WASHINGTON FORECAST DISTRICT

On the morning of the 3d, northwest storm warnings were ordered from Atlantic City to Boston and warning was given in radio bulletins that winds would be strong, reaching gale force at times, off the Middle and North Atlantic coast. Strong winds occurred along the coast and severe gales off the coast between Bermuda and Nantucket.

Storm warnings were ordered on the evening of the 5th from Atlantic City to Eastport in anticipation of the disturbance over Hudson Bay increasing in intensity, but winds did not reach dangerous proportions and warnings were accordingly taken down the following morning.

Warnings were hoisted on the evening of the 7th from Atlantic City to Eastport in connection with a disturbance over Ohio, and strong winds and gales occurred over the region indicated.

On the morning of the 12th, warnings of strong shifting winds were disseminated from Jacksonville to Sandy Hook and at 4 p. m. warnings of strong winds and gales were extended northward to Eastport. Warnings were ordered down south of Hatteras the night of the 12th, and warnings were continued north of Delaware Breakwater to Eastport on the 13th and 14th. Winds occurred substantially as indicated in the advices.

Warnings were ordered on the morning of the 15th from Wilmington to Boston in connection with a disturbance over the Lower Lakes and on the evening of that day were extended northward to Eastport. On the following day warnings were changed to northwest from Delaware Breakwater to Eastport, and on the 17th were continued from New London, Conn., to Eastport. Strong winds and gales occurred as forecast.

On the 21st storm warnings were hoisted from Hatteras to Eastport, but winds were only fresh to strong and did not reach gale velocities.

In connection with a disturbance over western Pennsylvania, warnings for strong, shifting winds were ordered on the 27th from Sandy Hook to Eastport and strong winds occurred substantially as indicated.

At 3 p. m. on the 30th, storm warnings were issued from Punta Gorda to Jacksonville, Fla., in connection with a disturbance of tropical origin central slightly west or northwest of the Tortugas. The disturbance moved northeastward with increased intensity across the Florida Peninsula, passing near and south of Tampa. It was attended by heavy rains, especially in the right front quadrant, a fall of 14.08 inches occurring at Miami, Fla. A discussion of the subsequent movement and warnings issued in connection with this disturbance will be found in the next issue of the MONTHLY WEATHER REVIEW.

On the 23d, norther warnings were sent to the chief hydrographer, Canal Zone, and fresh to strong north and northwest winds were indicated for the Caribbean. In his letter the chief hydrographer indicates that the wind occurred as stated in the advices.

In this connection the pilot-balloon run of November 24 at Kingston, Jamaica, is so interesting that it is given here: Surface—N—10 m p s; 250m—N—16 m p s; 500m—N—6 m p s; 750m—ESE—1 m p s; 1,000m—E—4 m p s; 1,500m—SE—2 m p s. It will be noted that the northerly current extended up to 500 meters.

Frost and freezing temperature warnings were issued for portions of the east Gulf and south Atlantic States, on the 8th, 9th, 15th, 17th, 20th, 21st, 22d, 23d, and 28th.—*R. H. Weightman.*

CHICAGO FORECAST DISTRICT

The weather in the Chicago forecast district during the month of November was rather variable, especially in the eastern portion. The mean temperature was below the average from the Mississippi Valley eastward and in most of Wyoming, and above in the balance of the district.

The total precipitation was below the normal, except in small scattered areas. The largest excesses were in the Ohio Valley and thence westward across the southern portions of Missouri and Kansas, due to the fact that the most important storms passed east-northeastward across the southern portion of the forecast district.

The principal storms affecting a considerable portion of the district were as follows:

1. Disturbance developing in the far West on the 1st–2d, the center reaching the Great Lakes by the morning of the 5th, attended almost generally by strong winds on the Lakes.

2. Disturbance which developed in the far Southwest, passing northeastward across the southern and eastern portions of the Chicago district on the 7th and 8th, attended by dangerous gales on the lower Lakes and rather strong winds on southern Lake Michigan.

3. A disturbance of apparently minor importance in the West, upon reaching the eastern portion of the district on the 12th–13th, increased decidedly in intensity. Storm winds were confined to the lower Lakes and southern Lake Huron.

4. A storm which moved from the western plateau east-northeastward over the southern portion of the forecast district and finally to the St. Lawrence Valley. The attendant gales in this case also were confined to the lower Lakes and southern Lake Huron.

5. A disturbance which appeared in Manitoba on the 20th, the center passing southeastward across Lake Superior on the 21st. The storm winds which occurred in connection with this disturbance were chiefly noted on Lake Superior and eastern Lake Michigan.

Storm warnings were ordered displayed at Lake stations at all points threatened well in advance of the appearance of these respective storms, and so far as known no casualties occurred except for the wreck of a barge in tow on Lake Superior on November 5. The towline broke, and the boat foundered, with the loss of the entire crew, consisting of six men and one woman.

No general cold-wave warnings were issued, but advices were limited to warnings on the 7th for the eastern portion of the forecast district and the 26th–27th from the Great Plains eastward across the upper Mississippi Valley and northern Lake region, decided falls in temperature following the passage of the barometric disturbances eastward across the district.

Special advices were sent to the Wenatchee Valley Traffic Association, Wenatchee, Wash., and other fruit-shipping interests in that section on each Monday morning during the month, covering the temperature conditions for the ensuing week; and it is believed that every one of these forecasts was fully verified, and that the shippers were enabled to arrange for the transfer of the crops eastward in a satisfactory manner.

From time to time special advices are furnished in connection with the protection of some project. An instance of this character is the special forecast sent to Alpena, Mich., on the morning of November 19, "Weather conditions now favorable for dredging outfit to proceed from Harbor Beach to Alpena. Moderately westerly winds and mostly fair weather indicated."

This was in response to correspondence indicating that a dredging outfit, valued at $1,000,000, wished to proceed on Lake Huron from Harbor Beach to Alpena, moving at the rate of 6 miles an hour. November 19 was the first day following the receipt of the request when weather conditions appeared to be propitious, and the advice was accordingly sent to Alpena.—*H. J. Cox.*

NEW ORLEANS FORECAST DISTRICT

Moderate weather conditions prevailed during the month. Warnings for freezing weather were issued for the northern portion of the district on the 5th, 8th, 15th, 19th, and 27th, and warnings for frost to the coast were issued on the 8th, 15th, 16th, and 20th; freezing and frosts occurred in the areas covered by these warnings.

Cold-wave warnings were issued on the morning of the 7th for Oklahoma and Arkansas and repeated in the evening for Arkansas; subsequent conditions justified the warnings.

Small craft warnings were displayed on parts of the Texas coast on the 5th, 14th, 19th, and 22d. No general storm occurred without warning. "Norther" warning was issued for Tampico, Mexico, on the 19th, and justified by subsequent conditions.—*I. M. Cline.*

DENVER FORECAST DISTRICT

Precipitation over considerable portions of the district attended disturbances which advanced eastward from California or the southern portion of the Rocky Mountain Plateau during the 1st-4th, 12th-13th and the 23d-24th. Heavy snow in southeastern and extreme eastern Colorado on the 6th and 7th resulted from a moderate low which was central over western New Mexico and eastern Arizona on the morning of the 6th but which increased rapidly in intensity during the day.

No general cold waves occurred and no warnings were issued. Falls in temperature sufficient to amount to local cold waves were noted at Flagstaff, Ariz., on the 8th and at Durango, Colo., on the morning of the 15th.

Frost warnings which were generally verified were issued as follows: For south-central Arizona, on the 5th and 16th; south-central and southeastern Arizona, on the 6th, 7th, 8th, 9th, 11th, 12th, 13th, and 14th; southern Arizona, on the 15th, 17th, and 18th.—*J. M. Sherier.*

SAN FRANCISCO FORECAST DISTRICT

The month opened with a disturbance in the process of formation over the plateau region, another already formed and moving eastward over British Columbia and an area of high barometric pressure of considerable magnitude over the Northeast Pacific Ocean. The plateau disturbance moved slowly eastward attended by scattered rains in this forecast district until the 4th, when it passed beyond the Rocky Mountains, and the pressure rose decidedly, the weather cleared and much lower temperatures overspread practically the entire forecast district, attended by frosts by the morning of the 8th as far south as the interior of southern California. Frosts were forecast from day to day in advance of their expected occurrence.

Following the 6th the barometer became quite low over the Gulf of Alaska and it remained so until the 18th, when the widespread disturbance in that region lost intensity and disappeared. In the meantime what seemed to be secondaries of this primary cyclone, moved onto the coast north of the mouth of the Columbia River and in every instance these were attended by sharp falls in pressure, gales and rains on the north coast. These were covered by the forecasts and warnings issued from the district forecast center. These changes, however, did not extend south of the north portion of northern California, for in southern California the weather remained fair and cool with light, local frosts in the interior.

The highest wind that occurred in connection with the disturbances on the north coast was on the 15th, when a velocity of 92 miles an hour from the south was recorded at North Head, Washington.

After the 18th, the pressure again fell, over and south of the Aleutian Islands, This disturbance advanced eastward, attended by gales over the northern part of the ocean. In fact, from this time on, the weather was stormy generally over the northeast Pacific Ocean, but relatively quiet over this forecast district, the exception being a disturbance of minor intensity which formed off the southern coast on the 23d and during the following 36 hours caused heavy local rains in southern California. During the last decade of the month a disturbance which first appeared north of the Hawaiian Islands advanced slowly eastward and at the close of the month its center was still off the California coast. It was seven days in moving from west longitude 165° to a position off the California coast, the center at all times being south of latitude 40°. This disturbance gave general rains at the close of the month throughout practically the entire forecast district. Announcements telling of the presence of this disturbance off the coast and the likelihood of its causing rains were issued from the forecast center well in advance of the occurrence of the rain.

The month was one notable for the number of disturbances over the high latitudes of the Pacific Ocean. Nearly all of these gave pressures well below 29 inches, and two of them gave pressures below 28.50 inches. Unquestionably the month was marked by heavy and frequent gales on the trans-Pacific steamer routes. Advices concerning the pressure, weather and wind conditions over the ocean were disseminated twice each day through the Navy radio stations on the Pacific coast for the benefit of shipping.—*E. H. Bowie.*

RIVERS AND FLOODS

By H. C. FRANKENFIELD

As will be noted in the table following this report, widely scattered rises—of short duration for the most part—occurred in the Middle West and South during November. They were in the main well forecast and the lossess resulting unavoidable. The following table, which is necessarily incomplete, gives for the more important cases the reported losses as well as the savings resulting from Weather Bureau flood warnings:

District	Losses (chiefly unhoused crops)	Savings by warnings
Houston, Tex.	$55,650	$67,500
Terre Haute, Ind.	13,000	25,000
Vicksburg, Miss.	15,000	(1)
Mobile, Ala.	(1)	1,500

[1] Not reported.

In the Houston, Tex., district the value of the flood forecasts was greatly increased by the use of radio as an additional method of dissemination. The official in

charge of the Weather Bureau office at that station reports that much favorable comment regarding this service was received.

In this connection it is well to add that the subject of radio dissemination of river forecasts and warnings is receiving increased attention, and daily reports are issued from Pittsburgh, Pa., Cincinnati, Ohio, and St. Louis, Mo. These daily reports include a bulletin giving the stages of the rivers at many points, the amount of precipitation, the daily river and weather forecasts, and a general summary of weather conditions. Flood warnings are of course broadcast from the above stations. From a few others also radio flood warnings are issued, a service which quite probably will be extended to other stations in the near future.

River	Station	Flood stage	Above flood stages—dates		Crest	
			From—	To—	Stage	Date
ATLANTIC DRAINAGE						
		Feet			*Feet*	
Saluda	Pelzer, S. C.	7	14	14	7.4	14
EAST GULF DRAINAGE						
Tombigbee	Lock No. 4, Demopolis, Ala.	39	13	19	43.3	17
MISSISSIPPI DRAINAGE						
Tuscarawas	Gnadenhutten, Ohio	9	14	------	9.0	14
Wabash	Mount Carmel, Ill.	16	19	14	16.6	21
Tippecanoe	Norway, Ind.	6	15	22	6.2	15
			23	23	6.2	23
White	Decker, Ind.	18	19	23	18.6	22-23
White, West Fork	Anderson, Ind.	12	14	14	12.2	14
	Elliston, Ind.	19	15	20	21.4	18
	Edwardsport, Ind.	15	10	21	18.2	19-20
Meramec	Pacific, Mo.	11	8	11	14.8	10
	Valley Park, Mo.	14	9	11	17.5	10
Bourbeuse	Union, Mo.	10	9	10	13.2	10
Neosho	Oswego, Kans.	17	9	9	17.2	9
Black	Williamsville, Mo.	11	9	9	11.2	9
	Poplar Bluff, Mo.	14	9	10	15.4	10
	Corning, Ark.	11	(1)	2	13.2	Oct. 20
			8	(2)	13.1	Nov. 15
	Black Rock, Ark.	14	8	16	17.5	
Cache	Patterson, Ark.	9	(1)	6	10.5	Oct. 22
			12	20	10.6	Nov. 15
Tallahatchie	Swan Lake, Miss.	25	12	20	26.4	20-21
WEST GULF DRAINAGE						
Sabine	Logansport, La.	25	11	13	26.0	12
	Bon Weir, Tex.	20	8	9	20.3	9
Trinity	Liberty, Tex.	25	7	18	27.3	12-14
Little	Little River, Tex.	30	7	7	42.0	7

[1] Continued from last month.
[2] Continued at end of month.

MEAN LAKE LEVELS DURING NOVEMBER, 1925

By UNITED STATES LAKE SURVEY

[Detroit, Mich., Dec. 5, 1925]

The following data are reported in the Notice to Mariners of the above date:

Data	Lakes [1]			
	Superior	Michigan and Huron	Erie	Ontario
Mean level during November, 1925:	*Feet*	*Feet*	*Feet*	*Feet*
Above mean sea level at New York	601.11	577.68	570.45	244.31
Above or below—				
Mean stage of October, 1925	−0.27	−0.21	−0.08	−0.01
Mean stage of November, 1924	−0.60	−1.09	−0.61	−0.64
Average stage for November last 10 years	−1.30	−2.33	−1.31	−1.08
Highest recorded November stage	−2.40	−5.24	−3.22	−3.51
Lowest recorded November stage	−0.39	−1.09	−0.25	+0.90
Average departure (since 1860) of November level from October level	−0.17	−0.27	−0.25	−0.25

[1] Lake St. Clair's level: In November, 1925, 573.06 feet.

EFFECT OF WEATHER ON CROPS AND FARMING OPERATIONS, NOVEMBER, 1925

By J. B. KINCER

General summary.—From the Mississippi Valley eastward November was moderately cool and generally wet, except that less than the normal amount of rainfall occurred in some Atlantic coast districts. The temperature over this area averaged slightly below normal, the deficiencies in nearly all cases being 1° or 2°. The rainfall was heavy in much of the area, particularly in parts of the Southeast where, locally, more than six times the normal precipitation was received. Generally from the lower Mississippi Valley northeastward precipitation ranged from 110 to 170 per cent of the monthly normal.

In the area between the Mississippi Valley and Rocky Mountains the month was somewhat warmer than normal in most sections, the mean temperature of the northern Great Plains being from 3° to 5° above the seasonal average. In most of the southern half of this area there was an excess in precipitation, but in the northern half it was mostly deficient, some stations reporting only 14 to 20 per cent of the seasonal average. In the central Rocky Mountains normal warmth prevailed with heavy precipitation, while to the westward the temperature averaged near normal, and precipitation was mostly light. The month was especially dry in the Southwest and in most Pacific districts, with some stations reporting an inappreciable amount of rainfall.

Snowfall was unusually heavy for so early in the season in the central Rocky Mountain area and in the western Lake region, the totals being as much as a foot or more in some sections. In the interior of the Northeastern States some stations reported from 6 to 9 inches of snow, while a trace occurred as far south as central Tennessee. In the trans-Mississippi States, the extreme northern portions of Arkansas and Oklahoma represent the southern limit of snowfall. Because of the continued rainy or snowy weather, the month was generally unfavorable for seasonal farm operations in most sections from the Mississippi Valley eastward. It was especially unfavorable for the seeding of fall grains, but in the South the last half of the month was more favorable for picking and ginning cotton.

Small grains.—Early sown wheat made good progress all the month in all sections, and at the end was furnishing some pasturage in Oklahoma and Kansas, though less than usual. Later sowings germinated slowly, but generally came up to a good stand. Because of wet weather, considerable acreage was abandoned in many sections of the Ohio and Mississippi Valleys. In the upper Lake region wheat was well protected by snow at the end of the month, but in portions of the west coast region was needing rain. Buckwheat threshing was delayed by rain, but was practically finished by the end of the month. Harvesting and threshing rice was also delayed considerably by wet weather, but on the whole made fair progress.

Corn.—Because of previous wet weather, conditions were unfavorable for gathering corn during the early part of the month, the fields being muddy and the grain having too large a moisture content. There was considerable complaint of corn molding in the shock and heating in the crib. Conditions gradually improved, and during the latter part of the month, husking and cribbing made good progress, except that they again became unfavorable in Iowa at the very last.

Cotton.—The first two weeks were unfavorable for gathering cotton. There was considerable lowering of

grade and damage by rain in many sections, and, in the extreme northwestern portion of the belt, some damage by freezing. During the last half of the month conditions were much better. Picking and ginning progressed rapidly, and, at the end of the month, picking was practically completed, except in the lowlands of Arkansas where there was much stained and low-grade cotton unpicked, and, in Tennessee and North Carolina, where there was still considerable cotton in the fields.

Fruit.—During the first week apples were badly damaged by the freeze in the Ohio Valley and New York. Conditions were generally favorable for the coloring and maturing of citrus fruits in all producing sections.

Miscellaneous crops.—The freeze during the first week did considerable damage to undug potatoes and delayed the digging of sugar beets from the Lake region west to the Rockies. This work was resumed later under more favorable conditions and, by the end of the month, was practically completed. Some truck was damaged by frost in the Gulf States, but truck generally made good progress in the Southern and west coast States. The sugar content of cane improved somewhat in Louisiana but is still low. Stripping tobacco made good progress in the Ohio Valley and eastward. The western ranges were generally in good condition throughout the month except in a few localities. In the Plains region and the Southeast, pastures that were damaged by the freeze were supplemented by fall-sown grains. In general livestock is in good to excellent condition everywhere at the end of the month.

CLIMATOLOGICAL TABLES[1]

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation by sections, November, 1925

Section	Temperature								Precipitation					
	Section average	Departure from the normal	Monthly extremes						Section average	Departure from the normal	Greatest monthly		Least monthly	
			Station	Highest	Date	Station	Lowest	Date			Station	Amount	Station	Amount
	°F.	°F.		°F.			°F.		In.	In.		In.		In.
Alabama	52.9	−1.6	2 stations	82	[3]7	St. Bernard	18	24	4.49	+1.40	Robertsdale	8.14	Seale	2.40
Alaska (October)	40.4	+5.1	Ketchikan	68	5	Allakaket	−9	31	8.21	−0.86	Latouche	33.22	Fort Yukon	0.31
Arizona	50.0	−1.7	Gila Bend	89	1	Bright Angel Ranger Station.	−10	8	0.71	−0.38	Bright Angel Ranger Station,	3.41	Gila Bend	0.00
Arkansas	50.4	−1.1	Jonesboro	89	12	Dutton	15	[3]25	5.67	+2.10	Huttig	14.41	Fayetteville	1.04
California	51.3	−1.1	Greenland Ranch	88	1	Helm Creek	−3	5	1.76	−0.70	Upper Mattole	9.19	2 stations	0.00
Colorado	32.7	−2.2	Wray	78	1	Hermit	−21	8	0.94	+0.06	Cuchara Camp	3.70	Buena Vista	0.07
Florida	64.5	−0.7	2 stations	91	[3]1	Garniers	24	24	4.09	+1.78	Miami	17.72	Lake City	0.79
Georgia	52.3	−2.4	2 stations	84	[3]6	2 stations	10	24	4.36	+1.71	Clayton	6.86	Brunswick	1.83
Hawaii	72.1	+0.7	Walanae	92	[3]1	Glenwood	45	[3]27	6.28	−2.88	Honokohau Ridge	45.00	Walawa	0.00
Idaho	35.1	+0.5	Glenns Ferry	73	1	Stanley	−10	23	1.26	−0.68	Prichard	2.90	Salmon	0.01
Illinois	39.8	−2.1	Sparta	76	12	Dixon	1	8	3.12	+0.72	McLeansboro	6.70	Marengo	0.82
Indiana	40.2	−1.9	Vevay	75	7	Goshen	2	29	4.48	+1.42	Salem	7.02	Collegeville	1.59
Iowa	36.1	−0.5	2 stations	68	21	2 stations	−6	8	0.71	−0.85	Maquoketa	2.30	Creston	0.05
Kansas	42.5	−1.6	2 stations	79	[3]4	3 stations	1	8	1.47	+0.31	Sedan	4.26	Oberlin	0.16
Kentucky	44.9	−1.4	3 stations	73	[3]7	Farmers	8	24	5.15	+1.62	Mount Sterling	7.42	Pikeville	3.34
Louisiana	57.9	−1.0	Schriever	86	[3]5	3 stations	23	23	5.50	+2.01	Calhoun	12.66	Clinton	1.34
Maryland-Delaware	43.2	−1.4	Millsboro, Del.	74	15	2 stations	6	[3]1	3.10	+0.57	Oakland, Md.	4.84	Solomons, Md.	2.22
Michigan	34.7	−1.5	2 stations	67	21	Sidnaw	−10	29	2.07	−0.41	Midland	4.88	St. James	0.30
Minnesota	29.5	−0.5	2 stations	67	20	Pine River Dam	−17	28	0.78	−0.32	Gonvick	2.70	Wadena	0.08
Mississippi	53.8	−1.4	Columbia	85	7	3 stations	22	23	5.62	+2.26	Cleveland	13.17	Poplarville	1.91
Missouri	42.8	−1.7	Hollister	80	26	Edgerton	−2	8	2.99	+0.64	Marble Hill	7.75	Conception	0.40
Montana	33.2	+1.2	Denton	70	[3]19	Outlook	−10	6	0.40	−0.59	Haugan	2.25	2 stations	0.00
Nebraska	38.0	+1.3	Alma	80	1	Pawnee City	−6	8	0.29	−0.45	Benkelman	1.01	5 stations	T.
Nevada	38.9	−1.3	Logandale	80	1	Millett	0	22	0.56	−0.02	Lamoille	1.92	2 stations	0.00
New England	37.3	+0.4	2 stations	68	[3]7	Garfield, Vt.	−20	30	3.65	+0.42	Somerset, Vt.	6.46	Waterbury, Conn.	1.62
New Jersey	42.0	−1.1	Vineland	76	15	Charlotteburg	10	1	3.40	+0.33	Dover	5.10	New Brunswick	2.48
New Mexico	40.9	−1.6	Carlsbad	85	14	Red River Canyon	−15	15	0.32	−0.29	Taos Canyon	2.19	24 stations	0.00
New York	37.6	+0.1	Sharon Springs No. 2	67	22	Gabriels	−11	29	3.62	+0.83	High Market	9.24	West Point	1.01
North Carolina	47.9	−1.6	Rockingham	80	7	Mount Mitchell	0	24	3.27	+0.80	Rock House	7.81	Durham	1.37
North Dakota	28.8	+2.2	New Salem	69	11	Carson	−17	7	0.25	−0.33	McLeod	1.09	2 stations	0.00
Ohio	39.6	−2.0	Portsmouth	69	8	Bellefontaine	10	9	4.06	+1.42	Kings Mills	7.84	Findlay	2.41
Oklahoma	48.9	−1.9	Poteau	81	12	Kenton	15	22	2.11	+0.06	Broken Bow	3.95	Kenton	0.41
Oregon	41.6	−0.1	McMinnville	70	1	Harney Branch Experiment Station.	5	5	3.05	−1.29	Mapleton	12.11	Paisley	0.04
Pennsylvania	39.5	−1.5	Uniontown	71	15	West Bingham	4	29	3.56	+0.89	Gordon	6.07	Neshaminy Falls	1.50
Porto Rico	76.2	−0.5	Arecibo	95	[3]1	2 stations	56	[3]24	7.35	+0.14	Rio Grande	17.64	Potala	2.09
South Carolina	50.4	−3.3	4 stations	82	[3]7	Caesar's Head	15	24	3.81	+1.52	Caesar's Head	9.52	Mars Bluff	2.00
South Dakota	34.2	+0.6	2 stations	70	[3]20	Eureka	−7	[3]7	0.44	−0.26	Menno	1.43	2 stations	0.00
Tennessee	47.2	−1.2	3 stations	76	[3]13	2 stations	9	24	4.78	+1.40	Union City	7.43	Elizabethton	1.51
Texas	55.8	−1.3	2 stations	93	[3]12	Clint	10	16	2.75	+0.41	Liberty	12.67	11 stations	0.00
Utah	36.1	−0.9	St. George	75	1	Woodruff	−20	14	1.06	+0.06	Silver Lake	3.27	2 stations	0.02
Virginia	44.6	−1.5	Williamsburg	78	8	Burkes Garden	3	24	2.47	+0.01	Chatham	4.16	Macon	0.92
Washington	39.2	−0.5	Centralia	68	18	Snyders Ranch	4	23	3.38	−1.40	Quinault	17.08	Toppenish	0.42
West Virginia	40.6	−2.4	Glenville	78	4	Terra Alta	6	1	3.66	+1.05	Rowlesburg	6.62	Upper Tract	0.65
Wisconsin	32.1	−1.6	Mondovi	66	20	2 stations	−16	[3]28	0.99	−0.80	Watertown	2.05	Grantsburg	0.27
Wyoming	30.8	−1.3	Eden	68	22	Riverside	−11	20	0.57	−0.10	Snake River	2.77	3 stations	0.00

[1] For description of tables and charts, see REVIEW, January, 1925, p. 42.

[3] Other dates also.

TABLE 1.—*Climatological data for Weather Bureau stations, November, 1925*

District and station	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷ 2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°*F.*	°*F.*	°*F.*		°*F.*	°*F.*		°*F.*	°*F.*	°*F.*	°*F.*	%	*In.*	*In.*		*Miles.*								*0–10*	*In.*	*In.*
New England							**39.8**	**+0.4**										**75**	**3.16**	**−0.4**										**5.1**		
Eastport	76	67	85	29.93	30.01	0.00	36.7	0.0	55	8	43	4	30	30	23	34	31	80	3.50	−0.6	9	9,087	w.	52	e.	13	12	1	17	6.0	0.2	0.0
Greenville, Me	1,070	6	----	28.83	30.03	----	30.2	----	52	5	38	−1	30	22	34	----	----	----	5.31	----	10	6,769	nw.	----	----	----	10	5	15	----	9.2	----
Portland, Me	103	82	117	29.94	30.07	+.06	38.9	+0.9	61	6	46	9	30	32	26	34	28	68	3.01	−0.8	8	6,981	sw.	56	se.	13	13	10	7	4.4	T.	0.0
Concord	289	70	79	29.74	30.06	.00	37.0	−0.7	64	8	47	6	30	27	38	----	----	----	2.75	−0.6	7	4,740	nw.	40	e.	13	12	8	10	4.9	1.8	0.3
Burlington	403	11	48	29.60	30.05	.00	35.8	−0.5	58	8	43	3	30	29	27	----	----	----	2.19	−0.4	11	9,725	s.	52	s.	8	6	8	16	6.6	3.8	1.0
Northfield	876	12	60	29.09	30.07	+.02	33.2	+0.4	60	8	43	−5	30	24	35	29	28	80	3.37	+0.8	14	5,566	s.	36	s.	8	8	8	14	6.3	5.6	2.5
Boston	125	115	188	29.93	30.07	+.02	43.6	+1.6	66	8	51	14	30	36	25	38	33	70	3.66	−0.4	8	8,005	w.	40	s.	16	13	8	9	4.6	T.	0.0
Nantucket	12	14	90	30.05	30.06	+.01	43.7	−0.7	60	8	49	26	29	38	21	40	36	79	3.18	−0.1	10	13,075	nw.	55	sw.	14	9	9	12	5.6	0.0	0.0
Block Island	26	11	46	30.05	30.08	+.02	44.0	−0.6	61	8	49	23	30	39	20	40	36	75	3.69	−0.2	11	15,957	sw.	56	e.	13	12	6	12	4.9	0.0	0.0
Providence	160	215	251	29.91	30.09	+.02	41.7	+1.3	65	8	49	16	30	34	26	37	31	70	4.11	+0.2	7	10,613	nw.	60	nw.	14	12	8	10	4.8	T.	0.0
Hartford	159	122	140	29.92	30.10	+.02	41.6	+2.1	62	8	50	18	30	34	27	----	----	----	2.09	−1.7	6	----	sw.	----	----	----	15	7	8	4.3	T.	0.0
New Haven	106	74	153	29.99	30.11	+.04	42.2	+0.2	63	8	50	21	30	35	23	38	34	75	3.22	−0.4	8	7,755	sw.	50	s.	16	13	11	6	4.1	0.3	0.0
Middle Atlantic States							**43.8**	**−0.9**										**72**	**2.68**	**−0.2**										**5.6**		
Albany	97	102	115	29.98	30.09	+.01	40.0	+0.7	62	8	48	16	30	32	27	35	31	75	2.93	+0.1	11	5,586	s.	36	s.	8	13	7	10	5.2	T.	0.0
Binghamton	871	10	84	29.14	30.09	.00	38.5	−0.2	61	8	46	17	29	31	34	----	----	----	2.22	0.0	15	5,522	nw.	36	sw.	7	6	6	18	7.1	1.3	0.0
New York	314	414	454	29.77	30.12	+.03	43.7	−0.5	66	8	50	24	29	37	24	38	32	67	2.56	−0.9	11	14,918	nw.	72	s.	16	7	13	10	5.7	0.2	0.0
Harrisburg	374	94	104	29.75	30.16	+.05	42.0	−0.8	65	15	49	26	29	35	28	37	31	70	4.32	+2.0	11	5,620	nw.	31	sw.	13	6	11	13	6.1	0.6	T.
Philadelphia	114	123	190	30.02	30.15	+.05	45.4	−0.3	68	15	52	27	29	39	25	30	33	65	2.97	−0.1	8	7,380	nw.	35	s.	15	11	8	11	5.3	0.2	0.0
Reading	325	81	98	29.78	30.15	----	42.4	----	67	15	50	25	30	35	29	38	34	75	3.30	+0.2	11	5,272	nw.	42	se.	12	11	10	9	5.1	0.5	0.0
Scranton	805	111	119	29.24	30.12	+.03	39.8	−0.7	62	15	47	20	29	32	28	36	34	82	2.87	+0.6	11	5,825	sw.	38	sw.	14	7	6	17	6.9	1.6	0.0
Atlantic City	52	37	172	30.06	30.14	+.04	45.4	−0.2	65	13	52	25	24	39	22	41	36	72	2.71	−0.5	9	14,630	w.	66	se.	12	13	9	8	4.5	T.	0.0
Cape May	17	13	49	30.16	30.18	+.08	45.3	−2.1	63	13	52	25	29	40	19	41	37	75	2.52	−0.7	8	7,923	n.	40	se.	12	13	4	13	5.3	0.0	0.0
Sandy Hook	22	10	55	30.10	30.12	----	44.0	----	65	8	50	27	29	38	22	39	34	71	3.01	----	10	13,590	sw.	68	s.	16	9	11	10	5.4	T.	0.0
Trenton	190	159	183	29.92	30.13	----	43.0	----	68	15	51	25	29	35	27	38	32	68	2.63	−0.8	9	9,125	nw.	54	sw.	16	7	13	10	6.0	1.2	0.0
Baltimore	123	100	113	30.02	30.15	+.04	45.4	−0.9	69	15	53	28	24	38	27	40	35	71	3.16	+0.2	9	4,510	sw.	28	sw.	13	11	9	10	5.5	0.2	0.0
Washington	112	62	85	30.03	30.16	+.04	44.3	−0.9	69	15	52	26	24	36	31	39	33	66	3.53	+0.8	10	5,293	nw.	38	nw.	14	11	6	13	5.7	T.	0.0
Cape Henry	18	8	54	30.12	30.14	----	50.0	----	75	8	57	30	24	43	31	45	41	75	1.84	−0.9	11	12,585	ne.	51	n.	23	13	7	10	5.1	0.0	0.0
Lynchburg	681	153	188	29.41	30.17	+.04	45.6	−1.6	69	15	55	23	29	36	40	39	34	71	2.68	−0.1	11	5,763	w.	34	w.	13	11	5	14	5.7	0.0	0.0
Norfolk	91	170	205	30.06	30.16	+.05	50.2	−1.2	73	8	58	29	24	43	29	44	39	70	1.97	−0.8	10	11,564	n.	50	s.	15	12	8	10	5.1	0.0	0.0
Richmond	144	11	52	30.01	30.17	+.05	46.7	−1.6	71	15	56	25	24	38	29	41	36	72	1.55	−0.8	8	6,867	ne.	46	sw.	15	14	5	11	4.8	T.	0.0
Wytheville	2,304	49	55	27.73	30.17	+.04	40.3	−2.7	63	8	48	17	24	32	35	36	31	74	1.73	−1.3	14	5,492	w.	36	sw.	15	11	7	12	5.5	0.1	0.0
South Atlantic States							**52.3**	**−1.9**										**77**	**2.53**	**−0.2**										**5.6**		
Asheville	2,253	70	84	27.77	30.19	+.05	43.6	−1.5	68	14	53	19	24	34	34	38	34	74	2.43	+0.2	10	7,168	nw.	37	n.	15	12	4	14	5.6	T.	0.0
Charlotte	779	55	62	29.32	30.18	+.05	47.9	−2.7	73	14	56	22	24	39	28	43	39	77	3.37	+0.5	10	3,871	ne.	23	w.	13	11	4	15	5.6	0.0	0.0
Hatteras	11	11	50	30.13	30.14	+.03	55.4	−0.9	75	6	61	33	24	49	23	51	48	80	2.63	−2.0	8	12,512	n.	58	se.	12	10	7	13	5.8	0.0	0.0
Raleigh	376	109	110	29.76	30.18	+.05	48.7	−2.3	72	8	58	24	24	40	29	44	40	79	2.56	+0.2	12	6,315	ne.	33	w.	13	12	2	16	5.5	0.0	0.0
Wilmington	78	81	91	30.09	30.17	+.05	53.6	−2.4	76	8	62	27	24	45	28	48	45	78	2.04	−0.4	8	5,452	n.	36	sw.	15	11	7	12	5.4	0.0	0.0
Charleston	48	11	92	30.11	30.16	+.04	56.2	−1.9	76	8	63	32	24	49	21	51	47	78	3.09	+0.2	5	8,142	ne.	36	s.	12	10	8	12	5.5	0.0	0.0
Columbia, S. C	351	41	57	29.79	30.18	+.06	51.8	−2.2	76	7	61	24	24	43	31	45	41	73	2.08	−0.2	7	4,687	n.	27	sw.	12	12	5	13	5.2	0.0	0.0
Due West	711	10	55	29.42	30.21	----	48.8	----	73	7	58	24	24	40	28	----	----	----	3.75	----	10	6,330	ne.	32	w.	15	10	4	16	5.6	0.0	0.0
Greenville, S. C	1,039	113	122	29.05	30.16	----	48.6	−1.0	73	7	57	24	24	41	25	43	37	71	4.06	----	10	6,853	ne.	35	s.	12	12	3	15	5.4	0.0	0.0
Augusta	182	62	77	29.97	30.17	+.04	53.2	−1.3	78	6	62	28	24	44	33	48	44	79	3.29	+0.4	6	4,004	nw.	24	nw.	15	12	5	13	5.3	0.0	0.0
Savannah	65	150	194	30.09	30.16	+.04	56.5	−2.0	79	7	65	30	24	48	26	50	46	75	2.32	0.0	6	8,766	ne.	46	w.	15	13	4	13	5.3	0.0	0.0
Jacksonville	43	209	245	30.08	30.13	+.03	60.0	−2.2	82	8	67	32	24	53	26	54	51	79	1.51	−0.7	11	10,251	ne.	56	sw.	12	9	6	15	6.4	0.0	0.0
Florida Peninsula							**71.5**	**+0.4**										**75**	**8.32**	**+6.0**										**5.8**		
Key West	22	10	64	30.00	30.02	.00	75.2	+0.9	87	2	80	56	25	71	16	69	66	78	2.40	0.0	10	8,517	ne.	36	sw.	30	8	13	9	5.6	0.0	0.0
Miami	25	71	79	30.03	30.06	----	72.4	+0.4	85	1	78	44	24	66	25	66	63	73	17.72	+14.9	9	6,131	se.	29	se.	6	3	12	15	6.6	0.0	0.0
Tampa	35	79	87	30.05	30.09	+.01	66.8	−0.1	86	1	75	40	24	58	31	59	56	75	4.85	+3.1	6	5,419	ne.	25	nw.	16	9	10	11	5.8	0.0	0.0
Titusville	44	5	----	30.04	30.09	----	67.0	----	85	12	75	32	24	60	30	----	----	----	4.40	----	10	----	ne.	----	----	----	10	12	8	5.1	0.0	0.0
East Gulf States							**54.7**	**−1.4**										**75**	**4.80**	**+1.3**										**5.6**		
Atlanta	1,173	190	216	28.92	30.18	+.05	49.8	−2.3	73	7	58	26	24	42	30	44	39	74	4.46	+1.1	8	8,976	nw.	44	nw.	15	11	5	14	5.6	0.0	0.0
Macon	370	78	87	29.77	30.18	+.06	52.3	−1.9	78	7	62	27	24	42	33	46	41	72	4.01	+0.9	7	4,847	ne.	29	nw.	15	10	3	17	5.8	0.0	0.0
Thomasville	273	49	58	29.85	30.15	+.03	57.0	−1.5	81	6	66	31	24	48	32	50	46	75	5.84	+3.2	5	3,371	ne.	22	sw.	12	7	9	14	6.1	0.0	0.0
Apalachicola	36	42	49	30.09	30.13	----	59.6	----	77	12	67	37	24	52	27	55	51	78	2.54	----	5	7,292	ne.	31	n.	16	11	8	11	5.2	0.0	0.0
Pensacola	56	149	185	30.08	30.14	+.03	58.9	−1.3	78	7	66	33	23	51	29	54	50	75	7.78	+4.0	8	10,402	ne.	44	e.	11	9	9	12	5.9	0.0	0.0
Anniston	741	9	57	29.38	30.19	+.07	50.5	−1.4	78	7	61	21	24	40	38	----	----	----	4.56	+1.2	10	4,214	se.	21	nw.	15	9	8	13	5.4	0.0	0.0
Birmingham	700	11	48	29.41	30.19	+.07	51.8	−2.1	77	7	61	28	23	43	29	45	40	70	4.41	+1.0	8	5,340	e.	31	s.	7	12	4	14	5.6	0.0	0.0
Mobile	57	125	161	30.06	30.14	+.03	58.0	−0.6	78	7	67	34	23	49	27	52	48	76	3.38	−0.4	9	7,516	ne.	33	nw.	15	10	9	11	5.6	0.0	0.0
Montgomery	223	100	112	29.92	30.18	+.06	54.4	−1.4	79	7	64	31	24	45	30	48	42	71	3.42	+0.3	8	5,049	n.	26	nw.	15	10	7	13	5.6	0.0	0.0
Corinth	469	6	----	----	----	----	50.4	----	76	14	61	26	24	40	38	----	----	----	4.70	----	----	----	----	----	----	----	9	11	10	----	0.0	0.0
Meridian	375	85	93	29.76	30.17	+.05	52.9	−1.3	80	7	62	28	24	44	34	47	44	79	4.53	+0.4	7	4,186	ne.	22	se.	11	12	3	15	5.5	0.0	0.0
Vicksburg	247	65	73	29.89	30.18	+.06	55.6	−1.6	82	7	64	33	23	47	29	49	44	72	5.53	+1.3	10	5,118	se.	28	w.	15	13	3	14	5.5	0.0	0.0
New Orleans	53	76	84	30.08	30.14	+.04	60.8	−0.8	82	7	68	42	23	53	24	55	52	80	4.85	+1.1	8	5,494	ne.	24	n.	15	12	7	11	5.0	0.0	0.0
West Gulf States							**57.2**	**−0.5**										**75**	**4.22**	**+1.0**										**4.9**		
Shreveport	249	77	93	29.88	30.15	+.04	55.0	−1.0	79	14	64	34	23	46	30	50	46	76	9.49	+5.4	10	4,657	se.	31	w.	7	14	6	10	4.7	0.0	0.0
Bentonville	1,303	11	44	----	----	----	47.0	+0.3	69	4	59	22	8	36	36	----	----	----	2.44	----	6	4,223	s.	23	w.	12	19	7	4	----	0.3	0.0
Fort Smith	457	79	94	29.63	30.12	+.01	50.2	−0.8	72	12	60	28	23	40	35	43	38	70	2.85	−0.4	8	6,173	e.	39	nw.	7	13	8	9	4.6	0.0	0.0
Little Rock	357	136	144	29.75	30.14	+.02	51.4	−0.7	74	12	60	29	23	42	31	45	40	72	5.23	+0.6	9	5,890	s.	40	sw.	7	14	6	10	4.7	0.0	0.0
Brownsville	57	53	61	30.01	30.06	----	66.6	−0.6	86	5	74	40	23	59	30	60	58	84	1.75	----	7	5,556	n.	30	n.	15	7	14	9	5.2	0.0	0.0
Corpus Christi	20	11	73	30.08	30.10	+.03	63.8	−0.5	86	12	71	42	23	56	29	58	55	81	0.22	−2.2	6	7,908	n.	36	s.	4	12	8	10	5.1	0.0	0.0
Dallas	512	109	117	29.58	30.13	----	55.6	----	79	14	66	33	23	45	32	----	----	----	2.96	----	11	5,478	s.	36	nw.	14	15	9	6	3.7	0.0	0.0
Fort Worth	670	106	114	29.39	30.11	+.01	55.9	+0.4	80	25	66	34	23	46	34	47	40	62	2.05	−0.5	6	6,483	s.	37	w.	14	14	7	9	4.3	0.0	0.0
Galveston	54	106	114	30.07	30.13	+.04	61.6	−1.7	78	4	67	44	23	56	18	58	55	83	3.42	−0.6	6	8,253	n.	40	nw.	14	12	8	10	4.9	0.0	0.0
Groesbeck	461	11	56	29.63	30.11	----	56.0	----	79	4	66	32	23	46	32	----	----	----	4.78	----	10	6,935	n.	43	nw.	14	15	5	10	4.6	0.0	0.0
Houston	138	111	121	29.97	30.12	----	61.0	0.0	83	4	69	38	23	53	26	----	----	----	9.21	----	11	5,306	n.	29	n.	15	12	8	10	5.5	0.0	0.0
Palestine	510	64	72	29.60	30.13	+.02	55.9	−1.3	79	14	65	32	23	47	33	50	46	74	7.94	+4.3	9	5,250	n.	30	nw.	7	10	8	12	5.3	0.0	0.0
Port Arthur	34	58	66	30.08	30.12	----	59.8	----	81	7	67	37	23	53	20	54	51	80	2.08	----	9	6,302	ne.	37	nw.	14	11	6	13	5.8	0.0	0.0
San Antonio	693	119	132	29.38	30.11	+.03	60.2	−0.1	86	12	70	35	23	50	33	52	46	68	1.44	−0.3	8	5,136	ne.	38	nw.	14	13	7	10	5.0	0.0	0.0
Taylor	583	55	63	29.53	30.15	+.07	57.6	−0.1	82	12	68	31	23	48	35	----	----	----	5.29	+2.6	9	5,667	nw.	32	s.	14	10	9	11	5.7	0.0	0.0

Condensed climatological summary of temperature and precipitation of sections, November, 1925—Continued

Districts and stations	Elevation or instruments: Barometer above sea level	Elevation or instruments: Thermometer above ground	Elevation or instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest Daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
Ohio Valley and Tennessee	*Ft.*	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°F. 43.9	°F. −1.4	°F.		°F.	°F.		°F.	°F.	°F.	°F.	% 75	*In.* 4.37	*In.* +0.9		*Miles.*							*0–10* 6.0	*In.*	*In.*
Chattanooga	762	189	213	29.36	30.19	+.05	48.4	−2.6	73	7	56	24	24	40	28	43	38	72	6.20	+2.6	13	5,586	sc.	31	w.	15	11	5	14	5.4	0.0	0.0
Knoxville	995	102	111	29.09	30.17	+.04	46.8	−1.1	72	7	55	22	24	38	32	41	37	74	4.34	+0.7	13	4,223	ne.	26	sw.	15	11	8	11	5.4	T.	0.0
Memphis	399	76	97	29.72	30.16	+.04	51.4	−0.3	73	14	59	30	23	43	25	45	41	75	3.80	−0.8	10	4,905	se.	39	sw.	7	14	4	12	5.1	0.0	0.0
Nashville	546	168	191	29.58	30.18	+.06	48.0	−1.0	73	7	57	23	24	39	31	42	38	75	4.52	+0.7	11	6,494	s.	38	w.	15	13	6	11	5.2	T.	0.0
Lexington	989	193	230	29.07	30.17	+.05	43.2	−1.6	68	7	51	20	24	35	24				4.52	+1.0	8	10,446	sw.	56	sw.	7	8	5	17	6.3	0.3	0.0
Louisville	525	188	234	29.56	30.16	+.04	45.1	−1.6	69	7	54	22	24	37	29	40	35	74	3.89	−0.3	8	8,118	s.	39	sw.	15	7	10	13	5.9	T.	0.0
Evansville	431	139	175	29.67	30.15	+.03	45.0	−1.6	69	14	53	23	23	37	27	40	35	72	4.83	+0.7	9	8,093	sw.	40	sw.	7	5	15	10	5.8	T.	0.0
Indianapolis	822	194	230	29.22	30.13	+.03	40.4	−1.9	65	7	48	19	23	32	28	36	32	77	5.13	+1.6	11	9,181	s.	44	w.	7	9	9	12	5.8	1.3	0.0
Royal Center	736	11	55	29.29	30.12	------	36.8	------	60	21	45	13	28	28	27				3.42	------	11	8,051	w.	35	nw.	22	10	5	15	5.8	5.2	0.0
Terre Haute	575	96	239	29.49	30.12	------	40.8	------	64	7	49	19	23	33	33	36	32	75	4.67	------	10	7,350	s.	30	sc.	4	7	13	10	5.7	0.5	0.0
Cincinnati	627	11	51	29.45	30.15	+.03	42.2	−0.3	65	7	51	21	28	34	26		35	79	5.75	+2.5	9	5,946	sw.	34	sw.	15	8	8	14	6.1	0.5	0.0
Columbus	822	179	222	29.23	30.13	+.02	40.8	−1.1	63	8	48	22	9	33	37	36	32	77	3.40	+0.3	8	8,767	w.	38	w.	8	6	8	16	6.9	T.	0.0
Dayton	899	137	173	29.14	30.12	------	40.9	−1.1	64	7	49	20	23	33	27	36	31	74	4.95	+2.1	9	7,334	sw.	43	sw.	7	6	12	12	6.0	0.4	0.0
Elkins	1,947	59	67	28.06	30.19	+.07	38.7	−1.6	60	11	49	13	18	28	39	33	30	80	3.21	+0.4	15	4,737	w.	33	sw.	13	8	5	17	6.7	2.1	0.0
Parkersburg	637	77	82	29.49	30.16	+.04	42.6	−1.2	68	15	51	24	29	34	30	37	32	71	3.91	+1.1	11	4,344	sc.	28	w.	8	8	4	18	7.3	T.	0.0
Pittsburgh	842	353	410	29.21	30.14	+.04	40.6	−2.6	65	15	48	22	26	33	31	36	31	72	2.70	+0.2	12	9,230	w.	42	w.	16	7	8	15	6.8	1.2	0.0
Lower Lake Region							38.6	−0.8										77	3.35	+0.3									6.9		
Buffalo	767	247	280	29.22	30.06	+.01	38.6	−0.8	61	8	44	19	29	33	32	35	32	82	3.26	−0.1	13	16,049	w.	72	sw.	15	6	7	17	7.1	3.6	0.0
Canton	448	10	61	29.53	30.02	------	34.2	+0.3	59	8	42	−2	29	26	28	------	------	------	4.06	+0.6	14	8,782	w.	53	sw.	8	8	6	16	6.6	9.3	5.4
Oswego	335	76	91	------	30.06	+.01	38.8	−0.1	58	21	45	13	29	32	23	------	------	77	3.36	0.0	15	9,900	se.	39	s.	8	5	5	20	----	5.4	0.0
Rochester	523	86	102	29.49	30.08	+.03	39.5	+0.8	61	8	46	20	29	33	28	34	30	73	2.48	−0.3	13	7,398	w.	37	sw.	16	6	5	19	7.3	1.4	0.5
Syracuse	597	97	113	29.43	30.08	+.02	39.0	+0.3	60	8	46	14	29	33	26	------	------	------	3.56	+0.9	15	10,174	w.	55	sw.	8	4	8	18	7.5	3.5	T.
Erie	714	130	166	29.28	30.07	+.01	40.0	−1.4	64	8	46	23	30	34	31	36	32	76	2.90	−0.7	13	13,311	s.	60	s.	5	6	6	18	7.0	2.5	0.0
Cleveland	762	190	201	29.25	30.10	+.03	39.6	−1.3	64	7	46	23	9	33	35	35	32	77	3.60	+0.8	17	10,627	s.	49	s.	5	5	6	19	7.4	5.0	T.
Sandusky	629	62	70	29.41	30.11	+.03	39.8	−1.3	63	7	46	22	9	34	29	------	------	------	3.08	+0.3	11	6,959	sw.	36	sw.	7	5	8	17	7.0	0.2	0.0
Toledo	628	208	243	29.40	30.10	+.03	39.2	−1.2	59	21	46	21	9	33	22	35	31	76	3.66	+1.0	11	10,911	sw.	40	w.	16	7	7	16	6.4	0.1	0.0
Fort Wayne	856	113	124	29.15	30.10	------	38.1	−2.5	59	21	45	19	9	31	25	34	31	79	3.68	------	10	7,197	sw.	29	w.	22	10	4	16	6.2	0.3	0.0
Detroit	730	218	268	29.27	30.08	+.02	38.0	−1.3	57	21	44	21	29	32	22	34	29	73	3.52	+0.9	14	7,672	sw.	28	nw.	13	7	6	17	6.7	7.8	0.3
Upper Lake Region							34.3	−1.1										79	1.72	−0.7									6.6		
Alpena	609	13	92	29.35	30.03	+.02	33.8	−0.6	60	21	40	10	29	27	25	31	28	82	2.07	−0.5	12	8,842	w.	40	se.	4	8	4	18	6.7	9.0	1.2
Escanaba	612	54	60	29.35	30.03	.00	31.9	−1.2	58	21	39	6	29	25	25	29	25	79	1.22	−1.0	6	7,205	nw.	28	s.	5	11	8	11	5.3	2.9	2.2
Grand Haven	632	54	89	29.36	30.06	+.02	37.1	−1.4	56	5	43	18	29	31	23	34	31	81	1.94	−0.6	9	9,362	w.	43	w.	22	7	4	19	7.2	7.9	2.1
Grand Rapids	707	70	87	29.29	30.08	+.03	37.0	−1.4	57	21	43	21	29	31	23	33	30	77	2.08	−0.4	12	4,593	nw.	21	nw.	22	4	7	19	7.8	8.4	1.5
Houghton	668	62	99	29.27	30.02	.00	32.2	+0.2	56	20	38	12	28	26	31	------	------	------	1.00	−1.8	7	8,520	w.	58	w.	5	1	11	18	7.8	4.4	T.
Lansing	878	11	62	29.10	30.07	------	35.2	−2.3	59	21	42	17	29	28	28	32	31	90	3.11	+0.7	16	4,963	sw.	21	nw.	22	7	6	17	6.7	12.1	2.3
Ludington	637	60	66	29.34	30.05	------	36.1	------	55	4	42	14	29	31	23	33	30	78	1.24	------	14	9,153	nw.	40	s.	5	9	7	14	6.2	9.4	3.4
Marquette	734	77	111	29.18	30.01	−.01	33.3	0.0	56	21	40	10	28	27	25	29	26	78	0.97	−1.8	12	8,958	w.	43	sw.	17	3	12	15	7.1	8.7	2.1
Port Huron	638	70	120	29.35	30.06	+.01	36.2	−1.3	55	11	42	16	29	30	24	33	30	82	2.91	+0.2	9	9,010	sw.	39	nw.	13	7	10	13	6.5	2.4	0.6
Saginaw	641	69	77	29.35	30.06	------	35.0	−2.4	58	21	42	12	29	28	29	------	------	------	2.72	------	12	------	s.	------	------	----	6	2	22	----	4.3	0.7
Sault Sainte Marie	614	11	52	29.30	30.01	.00	32.4	+0.4	53	11	38	9	28	26	21	30	27	82	2.15	−0.8	14	7,454	se.	44	nw.	5	4	7	19	7.7	10.6	6.5
Chicago	823	140	310	29.18	30.09	+.02	39.0	−2.2	60	4	46	17	28	33	24	35	30	71	2.57	+0.1	9	8,023	w.	34	ne.	7	12	3	15	5.5	2.3	0.3
Green Bay	617	109	141	29.36	30.05	+.01	32.7	−1.3	57	21	40	6	28	25	27	29	24	75	0.48	−1.5	7	8,363	s.	34	w.	5	8	7	15	6.3	1.6	0.9
Milwaukee	681	125	139	29.31	30.07	+.02	36.6	−0.7	58	20	44	12	28	30	25	32	28	76	1.20	−0.8	6	7,844	w.	33	n.	7	11	6	13	5.7	9.5	2.9
Duluth	1,133	5	47	28.77	30.03	−.01	28.2	−1.8	61	20	37	−3	28	20	34	24	21	80	0.70	−0.9	5	9,527	w.	48	nw.	21	9	10	11	5.5	1.6	1.3
North Dakota							28.9	+2.5										76	0.46	−0.3									5.3		
Moorhead	940	50	58	28.99	30.04	−.03	27.8	+0.7	56	20	37	−5	8	19	33	25	22	80	1.24	+0.3	6	6,010	s.	28	se.	3	6	11	13	6.3	4.2	0.9
Bismarck	1,674	8	57	28.25	30.10	+.03	30.8	+2.3	63	20	43	−2	7	19	36	26	19	68	0.13	−0.6	1	6,108	nw.	42	nw.	21	14	6	10	4.5	1.5	0.8
Devils Lake	1,478	11	44	28.40	30.03	−.03	26.8	+4.2	58	20	36	0	27	17	32	23	20	80	0.30	−0.4	4	6,792	nw.	38	nw.	5	11	10	9	5.3	3.7	0.6
Ellendale	1,457	10	56	28.45	30.06	------	29.6	------	64	20	41	0	28	18	39	------	------	------	0.32	------	5	8,734	nw.	46	nw.	21	8	10	12	5.6	2.9	1.1
Grank Forks	835	12	89	------	------	------	26.4	------	58	20	36	−2	28	17	33	22	------	------	0.33	------	2	------	s.	46	se.	3	8	10	12	5.0	0.1	0.0
Williston	1,878	41	48	28.00	30.04	−.02	30.1	+2.9	56	20	40	−1	7	20	33	25	21	74	0.16	−0.4	5	5,365	sw.	37	nw.	21	13	7	10	5.1	0.4	T.
Upper Mississippi Valley							37.5	−1.0										77	1.79	−0.2									5.4		
Minneapolis	918	102	208	29.02	30.03	------	32.6	+0.2	63	20	41	6	27	24	27	------	------	------	0.53	−0.6	4	8,291	nw.	40	nw.	21	11	7	12	5.7	3.6	3.3
St. Paul	837	236	261	29.13	30.06	.00	31.7	−0.8	61	20	40	5	28	23	27	------	------	------	0.59	−0.7	4	8,782	se.	44	nw.	21	10	7	13	6.0	4.1	3.5
La Crosse	714	11	48	29.28	30.08	+.01	34.2	−1.0	63	20	43	2	28	26	36	------	------	------	1.59	+0.1	7	4,118	se.	19	w.	22	9	10	11	5.7	5.3	4.5
Madison	974	70	78	29.01	30.10	+.04	33.8	−1.4	59	20	42	9	28	26	28	30	27	82	1.16	−0.6	10	7,158	nw.	30	ne.	7	10	8	12	5.6	8.4	4.2
Wausau	1,247	4	----	28.68	30.06	------	30.6	------	55	20	38	−2	28	23	28	------	------	------	1.66	------	5	------	s.	------	------	----	5	9	16	7.2	4.0	2.2
Charles City	1,015	10	49	28.98	30.09	+.01	33.6	+0.6	62	20	43	6	28	24	34	29	25	80	1.15	−0.2	5	5,235	se.	25	nw.	21	14	9	7	4.5	6.5	4.8
Davenport	606	71	79	29.43	30.11	+.03	37.2	−1.8	60	20	46	9	8	29	29	33	29	79	1.10	−0.7	4	5,058	nw.	26	nw.	21	13	7	10	5.2	10.8	1.2
Des Moines	861	84	97	29.16	30.09	+.01	37.8	−0.6	64	20	48	7	8	28	34	33	28	73	0.32	−1.2	5	4,952	sw.	26	sw.	17	12	7	11	5.2	2.2	0.0
Dubuque	700	81	96	29.30	30.08	+.01	35.7	−1.3	60	20	44	10	28	27	30	31	27	77	1.28	−0.5	6	4,701	nw.	30	nw.	21	10	8	12	5.7	11.0	3.2
Keokuk	614	64	78	29.43	30.12	+.03	39.6	−1.5	66	21	49	9	8	30	30	34	29	72	1.04	−0.8	5	5,599	s.	28	nw.	21	9	14	7	5.0	4.7	0.0
Cairo	358	87	93	29.75	30.14	+.02	47.2	−0.1	70	14	56	26	23	39	28	42	37	75	4.59	+0.6	11	6,261	s.	33	nw.	15	10	8	12	5.6	0.0	0.0
Peoria	609	11	45	29.44	30.12	+.03	37.7	+0.2	64	21	46	12	8	29	29	33	30	83	2.70	+0.1	11	5,195	s.	29	nw.	21	13	10	7	4.8	4.8	T.
Springfield, Ill	636	10	91	29.41	30.11	+.01	39.5	−2.7	65	21	48	18	8	31	27	35	32	82	2.33	−0.3	9	6,609	w.	27	nw.	21	12	10	8	4.8	1.3	0.0
Hannibal	534	74	109	29.54	30.14	+.05	40.6	−1.5	66	21	50	14	8	32	31	------	------	------	2.57	+0.6	5	6,320	sw.	30	sw.	21	13	11	6	4.7	5.8	0.0
St. Louis	568	265	303	29.50	30.12	+.02	43.4	−1.7	67	21	51	23	8	36	28	38	33	71	4.09	+1.2	10	9,637	nw.	35	n.	15	13	8	9	4.7	0.1	0.0
Missouri Valley							39.8	+1.0										68	1.10	−0.1									4.2		
Columbia, Mo	784	11	84	29.27	30.12	+.03	41.8	−1.5	65	21	51	16	8	32	34	------	------	------	3.16	+0.8	7	6,184	se.	31	nw.	12	14	8	8	4.4	2.6	0.0
Kansas City	963	161	181	29.05	30.11	+.02	44.4	+0.7	68	21	54	15	8	35	32	38	31	66	1.47	−0.4	6	7,701	s.	42	ne.	7	17	6	7	3.9	3.0	0.0
St. Joseph	967	11	49	29.04	30.10	------	41.4	------	65	20	52	10	8	31	32	36	30	70	1.07	------	3	5,914	nw.	37	nw.	21	18	6	6	3.4	4.7	0.0
Springfield, Mo	1,324	98	104	29.70	30.13	+.03	45.0	−0.7	64	4	54	19	8	36	38	38	33	70	2.05	−0.6	6	8,107	se.	38	w.	12	17	7	6	3.6	0.8	0.0
Iola	984	11	50	29.04	30.12	+.03	44.2	+1.2	68	13	56	16	8	32	36	------	------	------	3.30	+1.9	6	4,900	s.	27	n.	7	16	7	7	4.3	T.	0.0
Topeka	987	92	107	------	------	------	43.1	+0.3	68	4	54	10	8	32	33	------	------	------	1.12	−0.1	4	6,500	w.	37	n.	21	17	6	7	3.7	4.5	0.0
Drexel	1,299	10	54	28.65	30.08	------	37.8	------	64	11	49	11	8	27	32	------	------	------	0.13	------	3	7,375	s.	36	sw.	17	14	7	9	4.4	T.	0.0
Lincoln	1,189	11	84	28.80	30.10	+.02	40.3	+1.2	67	11	52	14	8	29	32	34	29	71	0.06	−0.8	2	6,710	s.	47	nw.	21	14	6	10	4.7	0.5	0.0
Omaha	1,105	115	122	28.88	30.10	+.02	40.2	+1.7	66	20	50	17	8	30	30	33	26	63	0.12	−0.9	3	5,800	nw.	43	n.	21	19	3	8	3.7	T.	0.0
Valentine	2,598	47	54	27.31	30.09	+.01	36.4	+1.6	66	20	50	7	27	23	40	29	22	64	0.13	−0.6	1	6,033	w.	34	nw.	21	10	17	3	3.6	1.3	0.0
Sioux City	1,135	94	164	28.85	30.10	+.02	37.1	+1.9	65	20	47	13	27	27	32	31	25	66	0.38	−0.6	4	7,999	nw.	47	nw.	21	12	12	6	4.6	0.2	0.0
Huron	1,306	59	74	28.66	30.10	+.02	33.2	+1.7	60	20	44	5	28	22	36	28	23	72	0.62	0.0	3	6,089	s.	34	nw.	21	12	12	6	4.7	3.2	0.5
Pierre	1,572	70	75	28.39	30.10	+.02	36.2	+2.6	65	20	47	8	27	25	39	30	24	68	0.43	0.0	2	5,229	nw.	40	nw.	21	16	8	6	4.2	3.8	0.0
Yankton	1,233	49	57	28.71	30.07	−.01	36.0	+0.7	68	20	47	11	27	25	35	------	------	------	0.41	−0.4	3	4,849	w.	34	nw.	21	12	9	9	5.0	1.0	T.

Condensed climatological summary of temperature and precipitation of sections, November, 1925—Continued

Districts and stations	Elevation or instruments: Barometer above sea level	Elevation or instruments: Thermometer above ground	Elevation or instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. +2 mean min. +2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest Daily range	Mean wet thermometer	Mean temperature of the dew point	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	Ft.	Ft.	In.	In.	In.	°F.	°F.	°F.		°F.	°F.		°F.	°F.	°F.	°F.	%	In.	In.		Miles.								0–10	In.	In.
Northern Slope							33.9	+1.2										70	0.48	−0.3										5.2		
Billings	3,140	5					36.0		62	23	47	12	1	25	35				0.44		3		nw.				20	1	9		7.0	0.0
Havre	2,505	11	44	27.36	30.05	+.02	34.5	+3.3	60	19	45	14	30	24	39	30	26	75	T.	−0.8	0	5,518	sw.	28	sw.	25	12	12	6	4.4	T.	0.0
Helena	4,110	87	112	25.83	30.13	+.03	33.3	+0.1	50	29	41	10	4	25	26	28	23	69	0.16	−0.6	6	5,052	sw.	29	sw.	17	5	12	13	6.5	2.6	0.0
Kalispell	2,973	48	56	26.99	30.11	+.04	33.3	+0.9	48	17	40	17	27	26	22	30	27	78	0.47	−1.4	8	2,773	nw.	33	nw.	20	5	10	15	6.8	1.7	0.5
Miles City	2,371	48	55	27.52	30.13	+.06	35.7	+4.8	59	19	46	15	7	26	33	30	25	71	0.16	−0.4	6	3,672	s.	24	nw.	21	10	12	8	4.8	1.3	T.
Rapid City	3,259	50	58	26.63	30.13	+.05	37.8	+1.9	68	20	49	10	27	26	37	30	23	62	0.07	−0.4	4	5,488	w.	36	nw.	21	11	15	4	4.4	0.3	0.0
Cheyenne	6,088	84	101	24.02	30.12	+.05	35.0	+0.2	60	20	44	11	14	26	37	27	20	61	1.26	+0.8	6	9,476	w.	44	w.	12	9	12	9	5.3	12.9	0.8
Lander	5,372	60	68	24.68	30.20	+.10	28.6	−1.7	53	24	40	3	5	18	30	24	18	67	0.93	+0.3	3	2,649	sw.	38	w.	11	9	17	4	4.8	10.4	T.
Sheridan	3,790	10	47	26.13	30.14		32.2		60	23	44	8	5	20	38	26	22	75	0.29		9	2,650	nw.	28	nw.	11	11	12	7	4.9	2.7	0.0
Yellowstone Park	6,241	11	48	23.92	30.20	+.09	28.8	−0.5	46	1	37	8	7	21	30	25	20	72	0.94	−0.5	13	5,634	s.	34	sw.	25	5	13	12	6.3	6.8	3.0
North Platte	2,821	11	51	27.13	30.13	+.05	38.4	+1.8	67	20	52	14	22	25	46	30	23	67	0.37	0.0	3	4,865	nw.	39	n.	21	16	6	8	4.2	3.7	0.0
Middle Slope							43.0	+0.2										66	1.42	+0.5										3.3		
Denver	5,292	106	113	24.76	30.11	+.05	41.0	+1.2	68	23	52	16	15	30	31	33	25	61	0.67	+0.2	4	5,415	s.	29	w.	12	14	12	4	3.9	8.6	0.0
Pueblo	4,685	80	86	25.33	30.11	+.06	39.0	−0.4	73	23	53	10	8	25	43	31	24	62	1.30	+0.9	4	4,057	nw.	34	sw.	3	19	9	2	2.9	11.4	0.0
Concordia	1,392	50	58	28.59	30.10	+.02	41.4	0.0	64	20	53	12	8	30	32	34	28	66	0.70	−0.2	2	5,218	s.	33	n.	21	16	7	7	4.6	0.0	
Dodge City	2,509	11	51	27.48	30.14	+.07	42.6	0.0	73	3	56	16	8	29	42	34	29	70	1.77	+1.2	3	6,990	nw.	39	nw.	7	23	3	4	1.9	2.5	0.0
Wichita	1,358	139	158	28.63	30.10	+.02	45.2	+0.4	69	4	58	21	8	34	32	38	32	67	1.64	+0.5	5	9,180	s.	50	sw.	17	19	5	6	3.1	0.2	0.0
Broken Arrow	765	11	56	29.28	30.12		47.4		69	12	59	23	8	36	34				2.03		5	9,116	s.	46	n.	14	13	9	8	4.2	0.0	0.0
Oklahoma City	1,214	10	47	28.82	30.12	+.04	49.0	+0.2	71	11	60	24	8	38	33	42	38	73	2.42	+0.2	5	7,512	s.	36	n.	14	15	12	3	3.1	0.0	0.0
Southern Slope							51.2	−0.4										59	0.66	−0.5										3.4		
Abilene	1,738	10	52	28.29	30.12	+.05	53.4	−0.1	81	13	65	29	8	42	36	44	37	64	1.16	−0.1	4	6,096	s.	32	nw.	14	15	4	11	4.3	0.0	0.0
Amarillo	3,676	10	49	26.33	30.11	+.06	46.2	+0.7	75	23	59	25	22	33	43	37	30	64	0.95	−0.2	2	6,952	sw.	37	nw.	7	21	4	5	2.5	T.	0.0
Del Rio	944	64	71	29.11	30.11	+.06	57.8	−1.5	83	12	68	34	23	48	38				0.52	−0.7	7	5,092	se.	42	n.	14	16	5	9	4.4	0.0	0.0
Roswell	3,566	75	85	26.43	30.08	+.05	47.3	−0.8	80	13	64	22	23	31	51	36	24	50	T.	−0.9	0	4,627	s.	30	ne.	14	23	4	3	2.3	T.	0.0
Southern Plateau							48.1	−1.1										54	0.23	−0.3										2.6		
El Paso	3,778	152	175	26.26	30.09	+.09	52.3	−0.4	77	13	65	26	16	40	38	40	27	43	0.02	−0.6	1	6,382	nw.	37	w.	6	23	5	2	2.2		
Santa Fe	7,013	38	53	23.28	30.12	+.09	37.4	−1.5	59	2	48	11	15	26	30	29	22	62	0.58	−0.2	4	4,082	n.	27	n.	21	16	8	6	3.4	0.0	0.0
Flagstaff	6,907	10	59	23.39	30.07	+.05	35.3	+0.7	60	27	48	3	5	22	39	28		64	1.29		6	5,060	e.	25	s.	2	18	8	4		4.7	0.0
Phoenix	1,108	10	82	28.87	30.04	+.06	57.8	−1.9	83	1	73	33	16	43	43	46	36	53	0.12	−0.8	1	3,179	e.	21	e.	24	18	11	1	2.6	9.0	0.0
Yuma	141	9	54	29.90	30.05	+.07	60.5	−1.9	82	1	73	36	16	48	37	49	37	48	0.20	−0.1	2	4,226	n.	26	n.	14	24	4	2	1.6	0.0	0.0
Independence	3,957	5	25	26.05	30.13	+.08	45.4	−1.8	71	11	60	18	15	31	42	33			0.24	0.0	1		nw.				10	8	12	3.2	0.0	0.0
Middle Plateau							38.6	−0.6										62	0.68	−0.1										4.9		
Reno	4,532	74	81	25.56	30.18	+.07	40.0	−1.0	64	25	52	16	5	28	38	33	26	64	0.64	0.0	5	3,671	w.	36	sw.	11	10	15	5	4.6	2.3	0.0
Tonopah	6,090	12	20				39.0		54	1	46	18	4	32	21	31	22	55	0.34		4		se.									
Winnemucca	4,344	18	56	25.72	30.19	+.05	38.3	−0.1	62	1	52	14	5	25	39	31	26	70	0.66	−0.1	7	4,379	ne.	28	nw.	11	7	9	14	6.1	1.2	0.0
Modena	5,479	10	43	24.70	30.15	+.07	36.3	−0.1	61	30	51	11	23	22	40	28	21	62	0.48	−0.1	5	6,158	w.	43	sw.	1	17	6	7	3.7	2.2	0.0
Salt Lake City	4,360	163	205	25.73	30.17	+.05	39.8	−1.3	64	1	48	25	6	32	24	34	28	65	1.40	0.0	5	3,650	nw.	32	w.	2	10	5	15	5.7	4.4	0.0
Grand Junction	4,602	60	68	25.49	30.14	+.06	38.6	−0.7	64	1	50	19	21	27	32	31	23	58	0.23	−0.3	5	3,235	se.	32	sw.	3	12	11	7	4.4	0.3	0.0
Northern Plateau							39.1	−0.3										75	0.89	−0.5										7.0		
Baker	3,471	48	53	26.54	30.20	+.04	35.8	−0.1	53	18	45	18	7	27	31	32	28	75	0.21	−1.0	6	4,240	se.	36	sw.	11	6	7	17	6.7	T.	0.0
Boise	2,739	78	86	27.31	30.22	+.05	40.4	−0.6	58	9	49	24	7	32	28	36	30	70	1.19	+0.3	13	2,742	se.	23	ne.	16	9	6	15	6.3	0.0	0.0
Lewiston	757	40	48	29.34	30.16	+.04	42.8	+1.4	60	18	50	25	7	35	27				0.67	−0.6	11	1,721	e.	16	w.	11	2	10	18	7.5	0.0	0.0
Pocatello	4,477	60	68	25.57	30.18	+.04	37.4	+0.7	57	1	46	20	23	29	29	32	27	71	0.86	+0.3	10	5,342	se.	36	s.	16	7	10	13	6.1	0.2	0.0
Spokane	1,929	101	110	28.06	30.16	+.06	36.7	−1.8	53	9	43	20	6	30	26	34	32	83	1.59	−0.7	10	2,598	ne.	23	s.	20	2	10	18	7.6	5.2	1.5
Walla Walla	991	57	65	29.06	30.15	+.02	41.4	−1.4	61	16	48	25	22	35	25	38	34	79	0.83	−1.3	14	2,543	s.	26	s.	16	3	8	19	7.7	2.6	0.0
North Pacific Coast Region							47.0	+0.8										85	4.67	−1.9										7.6		
North Head	211	11	56	29.83	30.06	+.01	48.2	0.0	62	18	52	39	5	44	16	46	44	87	6.86	+0.5	24	12,050	s.	92	s.	15	6	1	23	8.1	0.0	0.0
Port Angeles	29	8	53		30.06		42.9		55	3	49	31	21	37	20				1.89	−2.6	18	3,549	s.	20	w.	19	5	10	15		0.0	0.0
Seattle	125	215	250	29.94	30.08	+.04	45.9	+0.3	62	18	51	32	22	41	19	44	41	82	3.83	−2.0	17	5,515	s.	34	sw.	10	6	6	18	7.3	0.0	0.0
Tacoma	194	172	201	29.86	30.08	+.04	46.5	+1.9	64	18	52	31	23	41	21				4.22	−2.4	21	4,719	s.	31	s.	14	3	9	18	7.6	0.0	0.0
Tatoosh Island	86	9	53	29.92	30.02	+.05	47.1	+1.2	55	18	50	41	27	44	11	45	43	88	7.18	−4.9	20	13,653	e.	71	e.	15	5	5	20	7.5	0.0	0.0
Yakima	1,071	5					37.2		62	20	49	12	23	25	39				0.47		5		ne.				6	11	13	6.3	2.0	T.
Medford	1,425	4					43.8		62	11	53	21	22	35	34	39	36	79	1.82		14		se.				4	2	24		0.0	0.0
Portland, Oreg	153	68	106	29.94	30.10	.00	46.0	−0.8	60	18	51	29	23	41	20	44	42	86	5.44	−1.0	20	3,673	se.	19	s.	9	2	4	24	8.7	0.0	0.0
Roseburg	510	9	57	29.57	30.13	+.01	48.0	+2.1	63	15	55	32	5	41	25	45	42	84	3.26	−1.1	19	1,559	s.	18	sw.	15	0	15	15	7.4	0.0	0.0
Middle Pacific Coast Region							53.4	−0.3										74	1.91	−1.1										5.5		
Eureka	62	73	89	30.07	30.14	+.03	51.7	+0.6	67	30	58	38	5	45	22	49	46	84	3.71	−2.0	14	3,689	se.	32	s.	15	5	7	18	7.0	0.0	0.0
Point Reyes	490	7	18	29.55	30.07		54.8	+1.8	71	20	59	46	7	50	15				3.12		9	11,467	nw.	61	nw.	3	6	13	11	6.0	0.0	0.0
Red Bluff	332	50	56	29.78	30.14	+.03	50.9	−2.9	74	21	61	32	5	41	35	45	39	68	1.43	−1.8	7	3,143	nw.	24	n.	4	11	10	9	5.5	0.0	0.0
Sacramento	69	106	117	30.06	30.13	+.04	53.0	−0.6	69	8	62	37	14	44	29	48	42	69	1.13	−1.0	7	3,925	se.	19	se.	11	14	10	6	4.5	0.0	0.0
San Francisco	155	208	243	29.96	30.13	+.04	56.6	+0.3	66	22	62	47	26	51	16	51	47	76	2.32	−0.2	8	4,671	nw.	34	w.	2	12	9	9	4.8	0.0	0.0
San Jose	141	12	110	29.99	30.15		53.4	−1.0	72	15	65	33	15	42	39				0.96	−0.5	10	3,543	s.	26	sw.	15	7	14	9	5.3	0.0	0.0
South Pacific Coast Region							58.8	+0.8										59	0.52	−0.7										4.0		
Fresno	327	89	98	29.76	30.13	+.07	54.2	0.0	72	19	65	34	5	43	31	47	39	61	0.20	−0.8	3	2,963	nw.	26	nw.	13	14	8	8	4.3	0.0	0.0
Los Angeles	338	159	191	29.70	30.07	+.05	62.4	+1.5	81	19	71	47	5	53	27	50	39	51	0.68	−0.8	2	3,972	ne.	26	nw.	13	19	3	8	3.7	0.0	0.0
San Diego	87	62	70	29.96	30.05	+.03	60.8	+1.1	81	20	69	46	15	53	25	53	46	65	1.16	+0.3	4	3,936	nw.	24	w.	3	16	7	7	4.0	0.0	0.0
San Luis Obispo	201	32	40	29.91	30.13	+.07	58.0	+0.7	83	22	71	36	15	45	42	48	39	59	0.05	−1.6	3	2,507	n.	16	ne.	24	14	10	6	4.0	0.0	0.0
West Indies																																
San Juan, P. R	82	9	54	29.85	29.94		78.1	−0.3	89	22	84	70	15	72	17				3.95	−3.0	17	7,066	e.	36	n.	6	8	17	5	5.2	0.0	0.0
Panama Canal																																
Balboa Heights	118	7	97	29.72	29.84	.00	80.0	+0.9	90	16	86	72	17	74	17	75	74	92	3.52	−6.6	19	3,850	nw.	23	nw.	24	1	11	18	7.6	0.0	0.0
Colon	38	7	97	29.81	29.85	.00	80.4	+1.2	90	6	86	72	23	75	16	76	75	90	22.95	+1.8	27	4,938	w.	32	nw.	25	0	9	21	8.1	0.0	0.0
Alaska																																
Juneau	80	11	54				40.4		54	7	44	30	25	37	13	38	37	88	11.74		27	6,024	se.	34	se.	21	0	1	29	9.8	0.7	0.0
Hawaiian Islands																																
Honolulu	38	86	100				75.2		84	4	80	64	25	71	13	68	64	70	1.35	−2.5	17	7,253	e.	31	ne.	27	8	12	10	5.7	0.0	0.0

TABLE 2.—*Data furnished by the Canadian Meteorological Service, November, 1925*

Station	Altitude above mean sea level, Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max.+ mean min.÷2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	*Inches*	*Inches*	*Inch*	*°F.*	*°F.*	*°F.*	*°F.*	*°F.*	*°F.*	*Inches*	*Inches*	*Inches*
St. Johns, N. F.	125												
Sydney, C. B. I.	48												
Halifax, N. S.	88												
Yarmouth, N. S.	65												
Charlottetown, P. E. I.	38												
Chatham, N. B.	28												
Father Point, Que.	20	29.91	29.93	−0.03	29.2	+0.3	35.2	23.2	50	−2	4.20	+1.09	14.6
Quebec, Que.	296	29.67	30.01	−0.01	30.0	+1.0	34.7	25.3	48	−6	3.43	−0.33	5.2
Montreal, Que.	187	29.79	30.01	−0.02	33.4	+1.6	39.2	27.7	55	0	3.49	−0.25	10.1
Stonecliffe, Ont.	489												
Ottawa, Ont.	236	29.76	30.04	+0.02	32.9	+1.2	40.3	25.6	55	−4	3.73	+1.19	5.4
Kingston, Ont.	285	29.73	30.05	+0.01	37.1	+2.1	43.0	31.3	54	6	3.84	+0.60	5.0
Toronto, Ont.	379	29.62	30.04	0.00	37.6	+2.0	43.3	31.9	56	14	3.65	+0.51	0.2
Cochrane, Ont.	930												
White River, Ont.	1,244	28.58	29.94	−0.04	23.2	+2.7	33.4	13.0	54	−27	1.47	−0.38	7.7
Port Stanley, Ont.	592												
Southampton, Ont.	656												
Parry Sound, Ont.	688	29.30	30.01	0.00	32.8	+0.7	37.9	27.8	50	6	4.01	−0.36	12.5
Port Arthur, Ont.	644	29.26	29.99	−0.01	26.9	+2.9	33.2	20.6	47	−7	0.65	−0.68	1.8
Winnipeg, Man.	760	29.14	30.00	−0.04	24.8	+6.8	31.8	17.8	58	−7	0.23	−0.85	2.1
Minnedosa, Man.	1,690	28.11	29.99	−0.05	22.6	+5.3	30.9	14.4	51	−8	0.29	−0.71	2.5
Les Pas, Man.	860				16.3		24.3	8.3	48	−33	0.52		5.2
Qu'Appelle, Sask.	2,115	27.55	29.96	−0.04	24.7	+5.9	32.4	17.0	50	−8	0.52	−0.37	0.6
Medicine Hat, Alb.	2,144	27.64	29.94	−0.06	32.6	+5.2	43.9	21.4	58	4	0.30	−0.62	3.0
Moose Jaw, Sask.	1,759				27.8		38.3	17.4	55	−6	0.28		2.8
Swift Current, Sask.	2,392	27.41	30.00	−0.02	29.0	+5.8	38.7	19.3	53	−10	0.15	−0.54	1.5
Calgary, Alb.	3,428	26.35	30.02	+0.04	29.4	+3.6	40.4	18.5	58	−1	0.64	−0.24	6.4
Banff, Alb.	4,521	25.32	30.03	+0.07	27.4	+1.6	35.3	19.5	46	−2	0.68	−1.59	6.6
Edmonton, Alb.	2,150												
Prince Albert, Sask.	1,450	28.38	30.01	−0.02	21.4	+6.0	30.0	12.9	52	−22	0.21	−0.62	2.1
Battleford, Sask.	1,592	28.18	29.98	−0.04	24.1	+7.8	35.4	12.8	52	−15	0.10	−0.48	1.0
Kamloops, B. C.	1,262												
Victoria, B. C.	230												
Barkerville, B. C.	4,180												
Triangle Island, B. C.	680												
Prince Rupert, B. C.	170												
Hamilton, Ber.	151	29.97	30.13	+0.08	66.6	−2.1	71.9	61.3	78	56	6.84	+2.46	0.0

LATE REPORTS, OCTOBER, 1925

Sydney, C. B. I.	48	29.74	29.79	−0.17	41.8	−4.7	50.1	33.6	62	28	9.28	+4.59	2.0
Halifax, N. S.	88	29.72	29.83	−0.17	43.4	−3.8	51.5	35.3	62	26	10.38	+4.83	3.5
Yarmouth, N. S.	65	29.73	29.80	−0.22	44.2	−3.4	50.4	38.1	59	25	5.86	+1.16	0.0
Charlottetown, P. E. I.	38	29.72	29.76	−0.20	42.4	−4.1	47.7	37.1	60	27	5.82	+0.92	T.
Chatham, N. B.	28	29.69	29.72	−0.24	38.2	−4.8	45.9	30.4	62	12	8.27	+4.41	18.3
Medicine Hat, Alb.	2,144	27.74	30.04	+0.07	36.6	−8.2	46.9	26.3	73	−2	0.39	−0.29	1.1
Calgary, Alb.	3,428	26.46	30.12	+0.17	33.2	−6.9	42.6	23.8	69	−5	1.33	+0.85	13.3
Banff, Alb.	4,521	25.41	30.07	+0.12	33.4	−5.9	42.9	23.9	59	−1	0.72	−0.30	3.9
Edmonton, Alb.	2,150	27.73	30.06	+0.13	32.7	−8.4	40.6	24.8	63	−4	1.29	+0.59	4.5
Kamloops, B. C.	1,262	28.82	30.14	+0.18	43.5	−3.5	53.5	33.5	64	26	0.60	−0.01	2.7
Barkerville, B. C.	4,180	25.72	30.07	+0.13	34.4	−5.3	43.7	25.1	57	−6	2.48	−0.23	17.0

Chart I. Tracks of Centers of Anticyclones, November, 1925. (Inset) Departure of Monthly Mean Pressure from Normal

Chart I. Tracks of Centers of Anticyclones, November, 1925. (Inset) Departure of Monthly Mean Pressure from Normal

(Plotted by Wilfred P. Day)

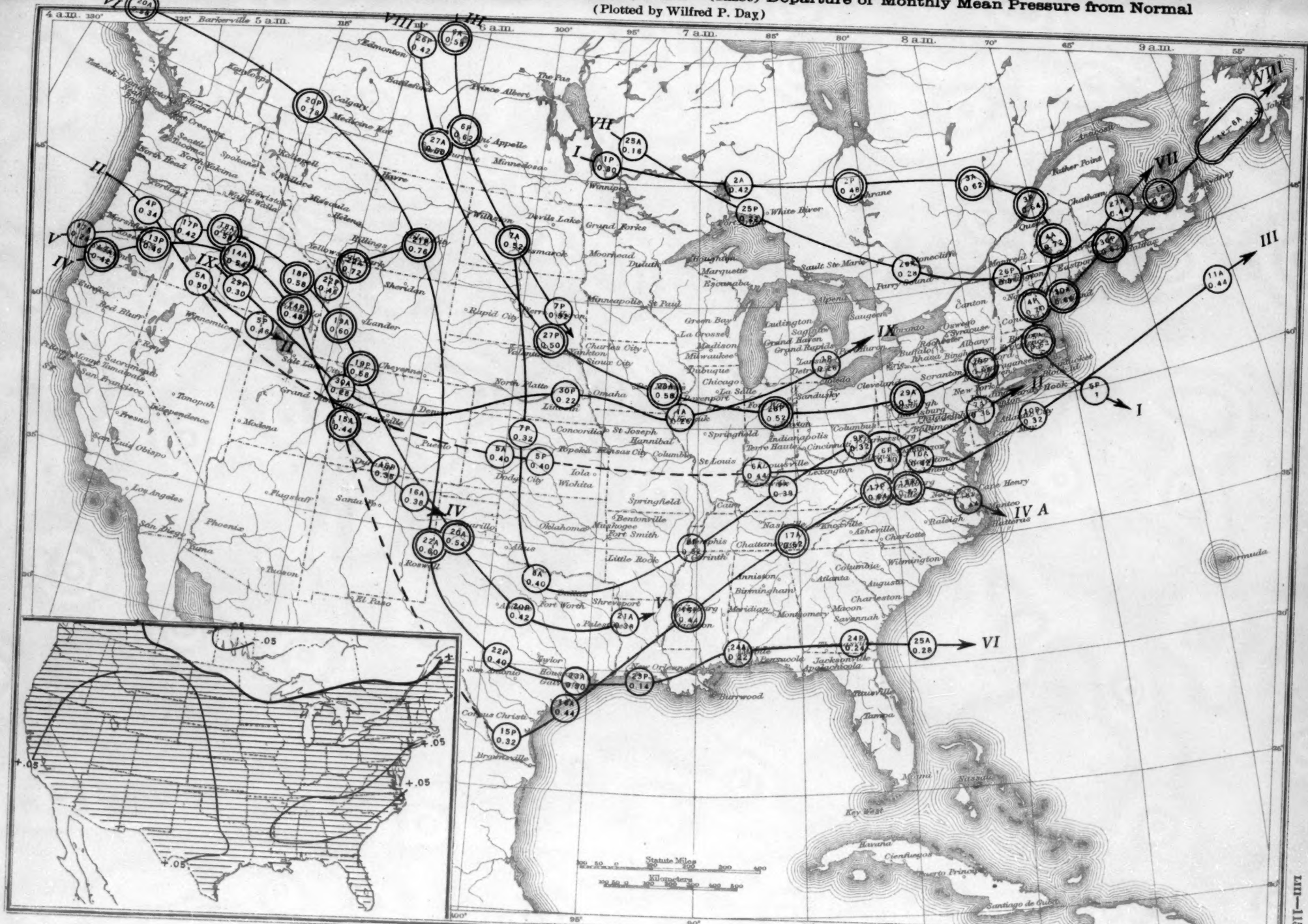

Chart II. Tracks of Centers of Cyclones, November, 1925. (Inset) Change in Mean Pressure from Preceding Month

(Plotted by Wilfred P. Day)

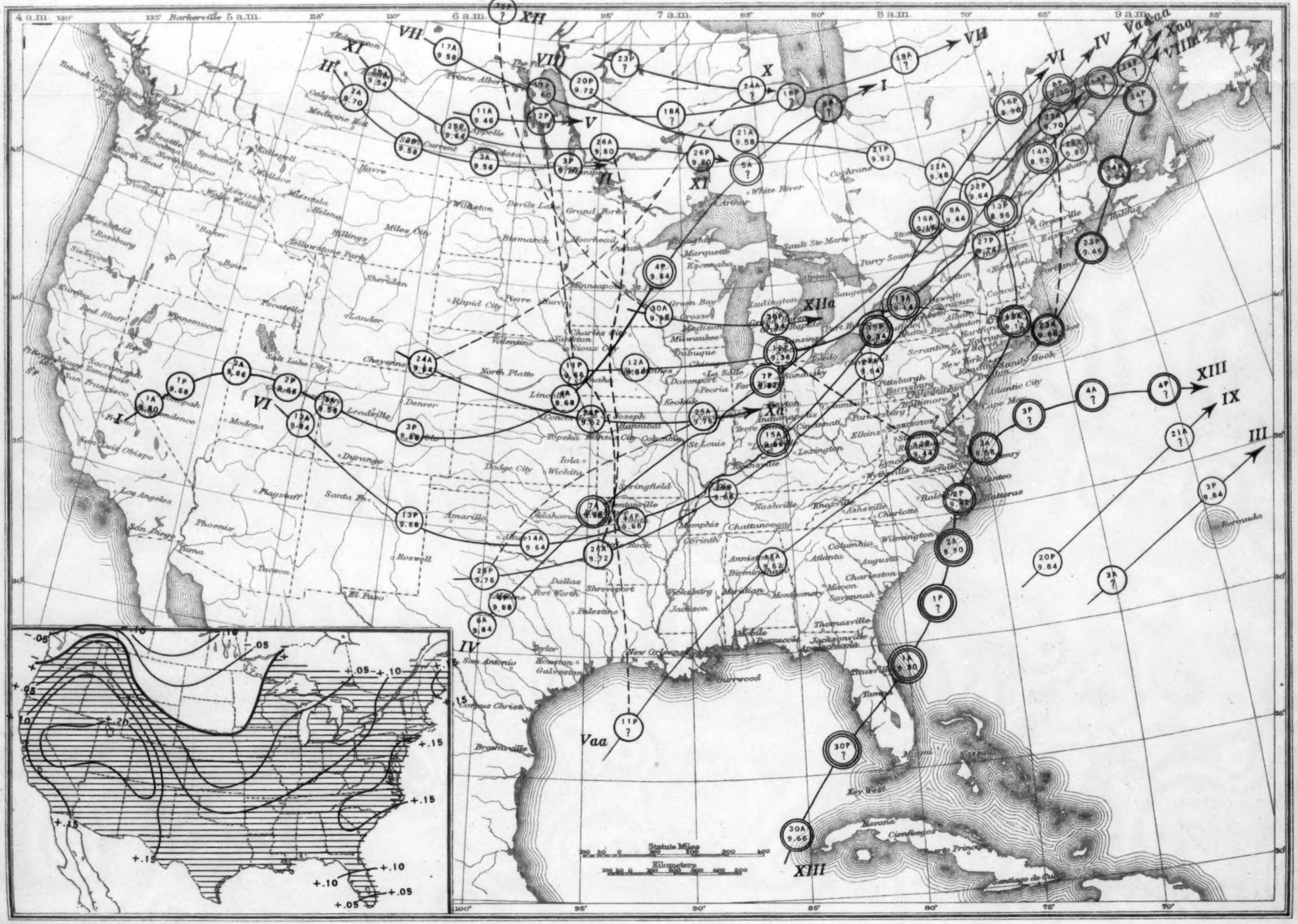

Chart III. Departure (°F.) of the Mean Temperature from the Normal, November, 1925

CHART III. Departure (°F.) of the Mean Temperature from the Normal, November, 1925

Shaded portions show excess (+).
Unshaded portions show deficiency (—).
Lines show amount of excess or deficiency.
Statute Miles
Kilometers

Chart IV. Total Precipitation, Inches, November, 1925. (Inset) Departure of Precipitation from Normal

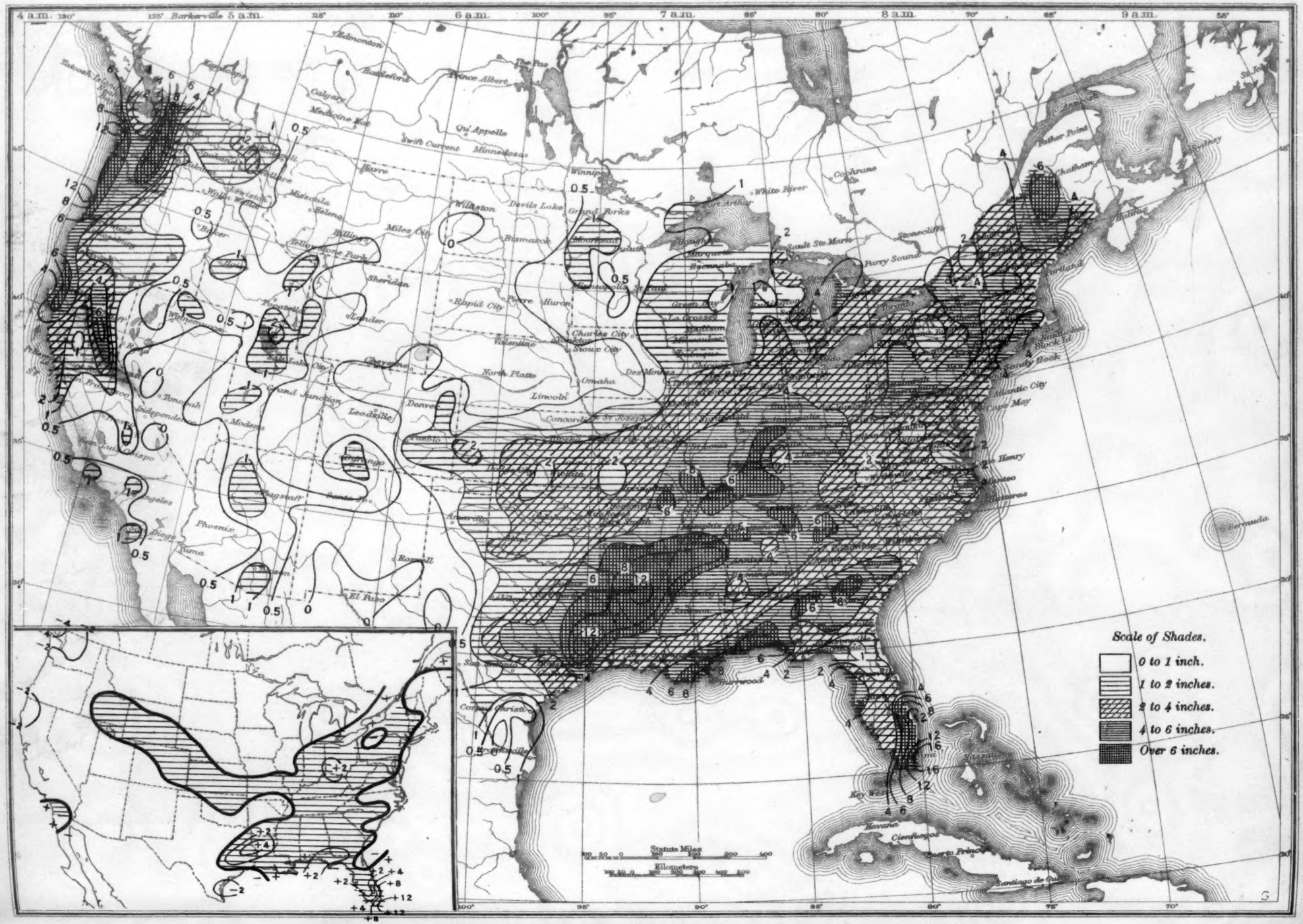

Chart V. Percentage of Clear Sky between Sunrise and Sunset, November, 1925

Chart V. Percentage of Clear Sky between Sunrise and Sunset, November, 1925

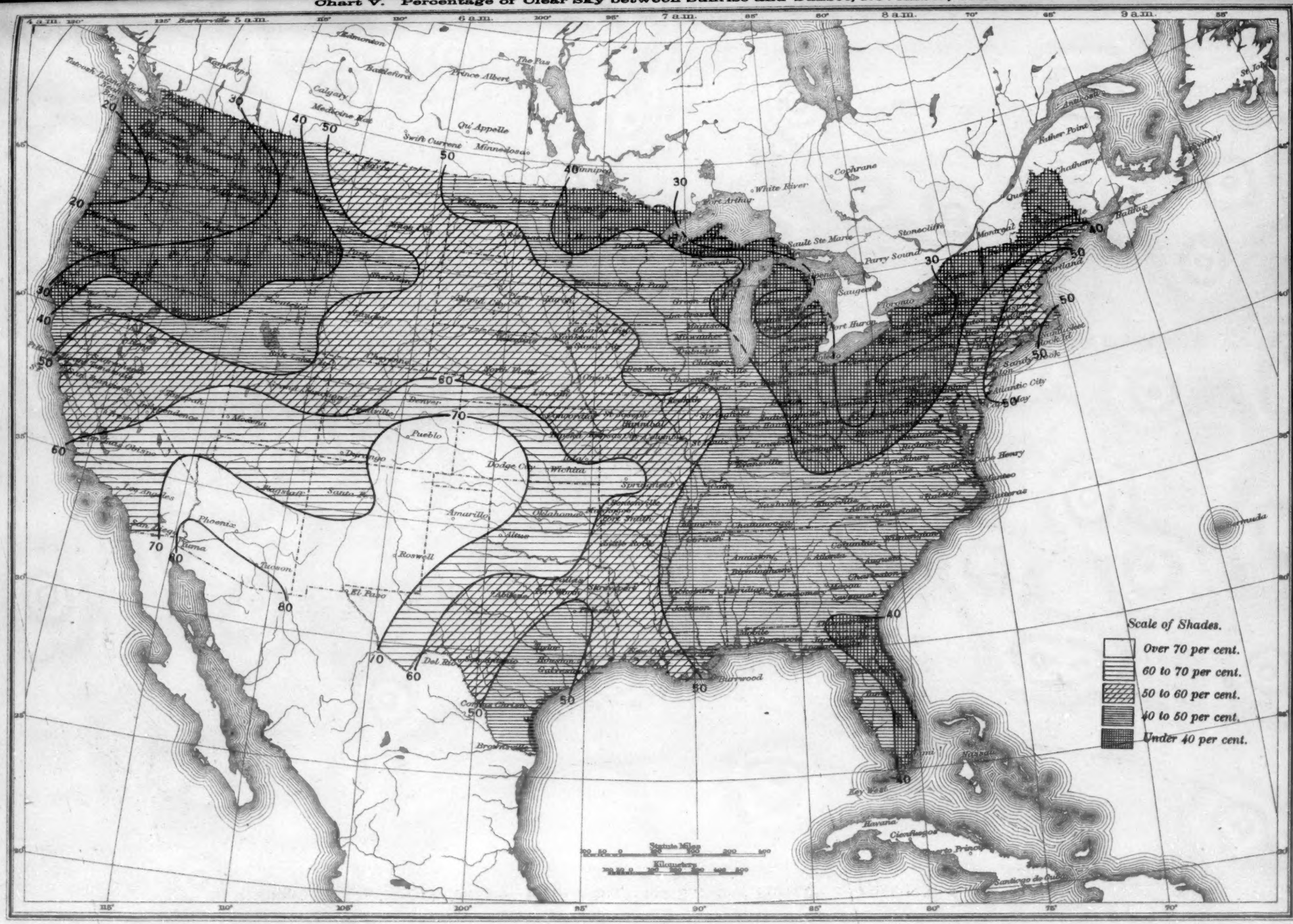

Chart VI. Isobars at Sea level and Isotherms at Surface; Prevailing Winds, November, 1925

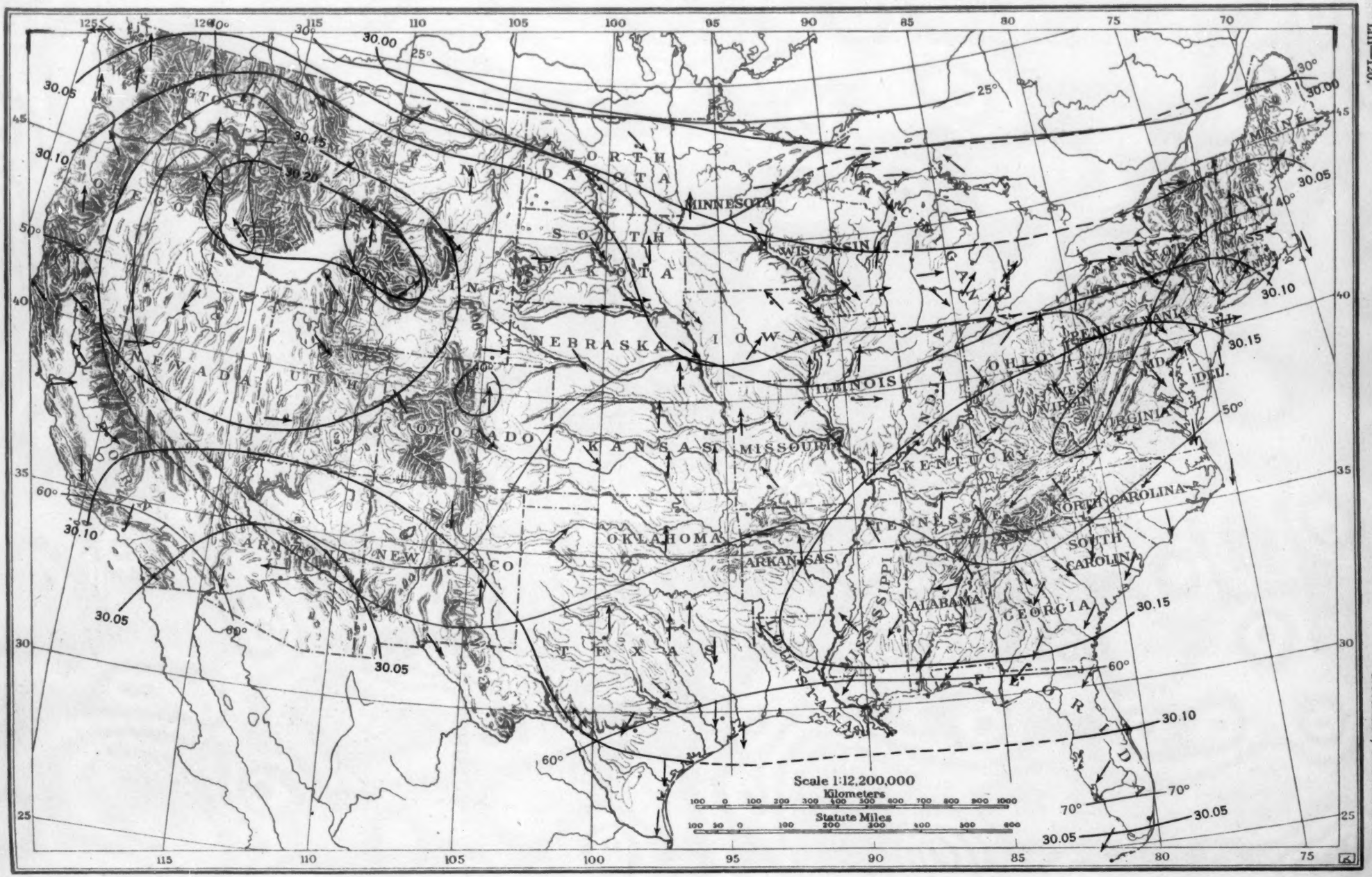

Chart VII. Total Snowfall, Inches, November, 1925.

Chart VII. Total Snowfall, Inches, November, 1925.

Chart VIII. Weather Map of North Atlantic Ocean, November 6, 1926
(Plotted by F. A. Young)

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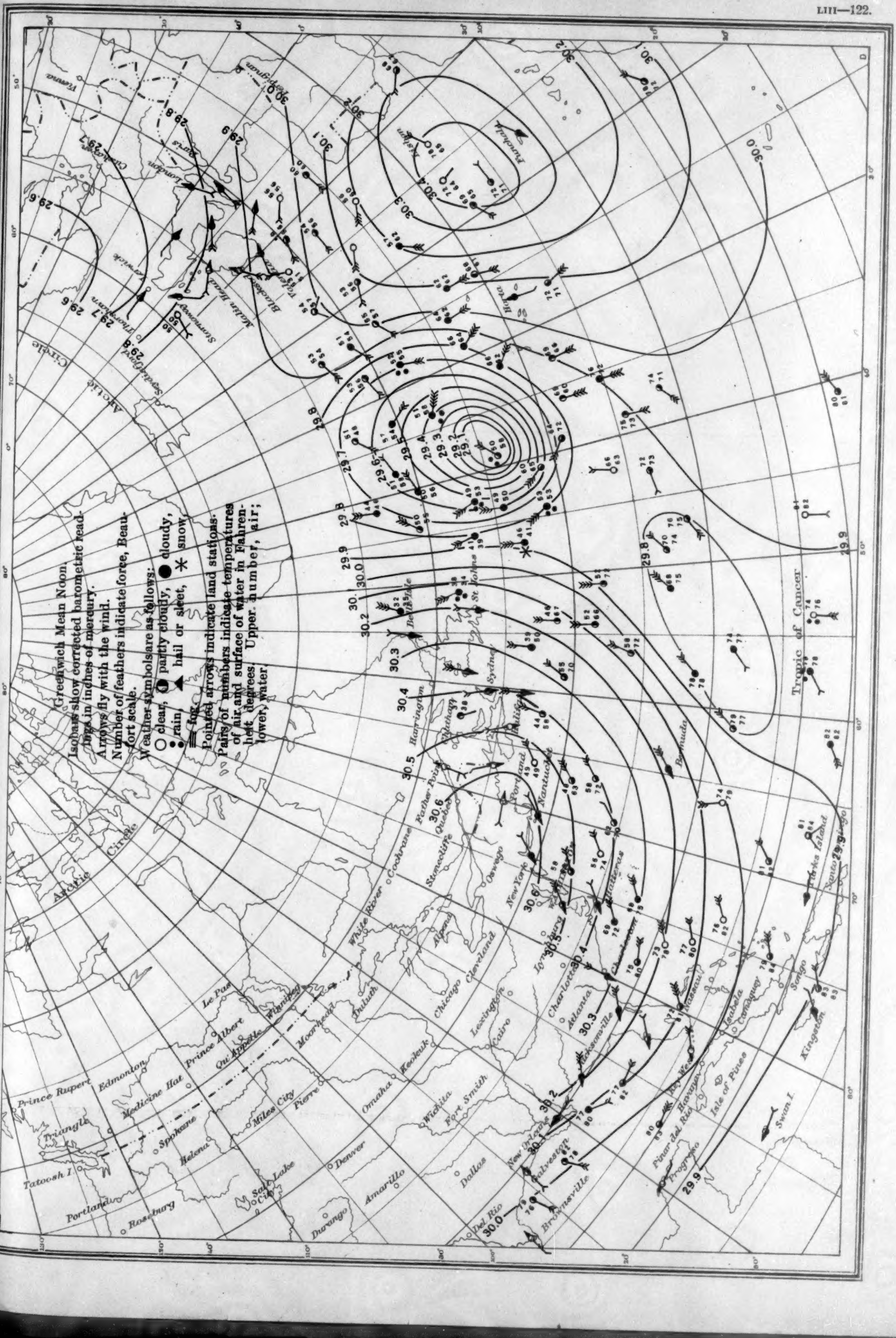


Chart VIII. Weather Map of North Atlantic Ocean, November 5, 1925
(Plotted by F. A. Young)

Chart IX. Weather Map of North Atlantic Ocean, November 6, 1925

(Plotted by F. A. Young)

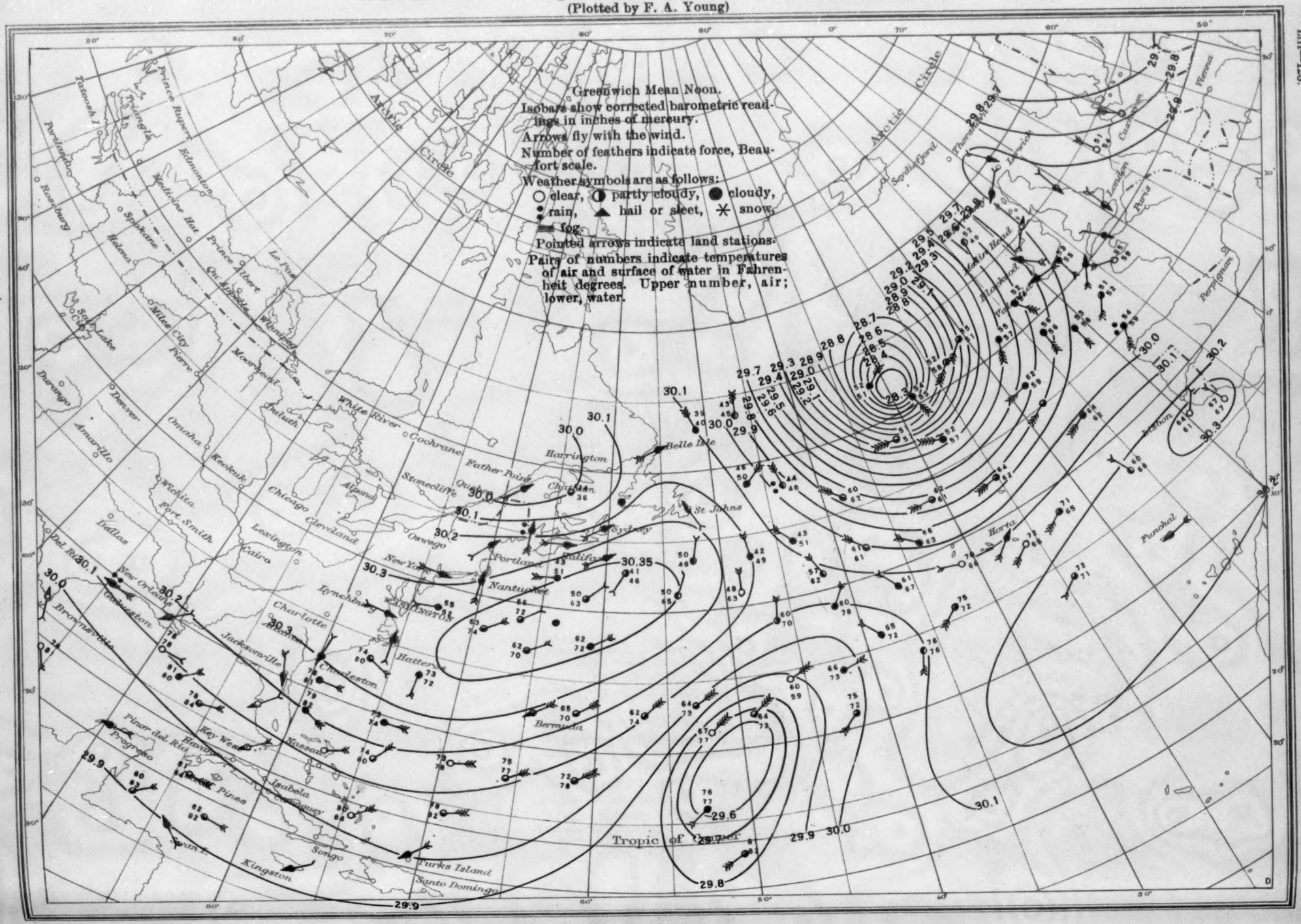


Chart X. Weather Map of North Atlantic Ocean, November 7, 1925

(Plotted by F. A. Young)

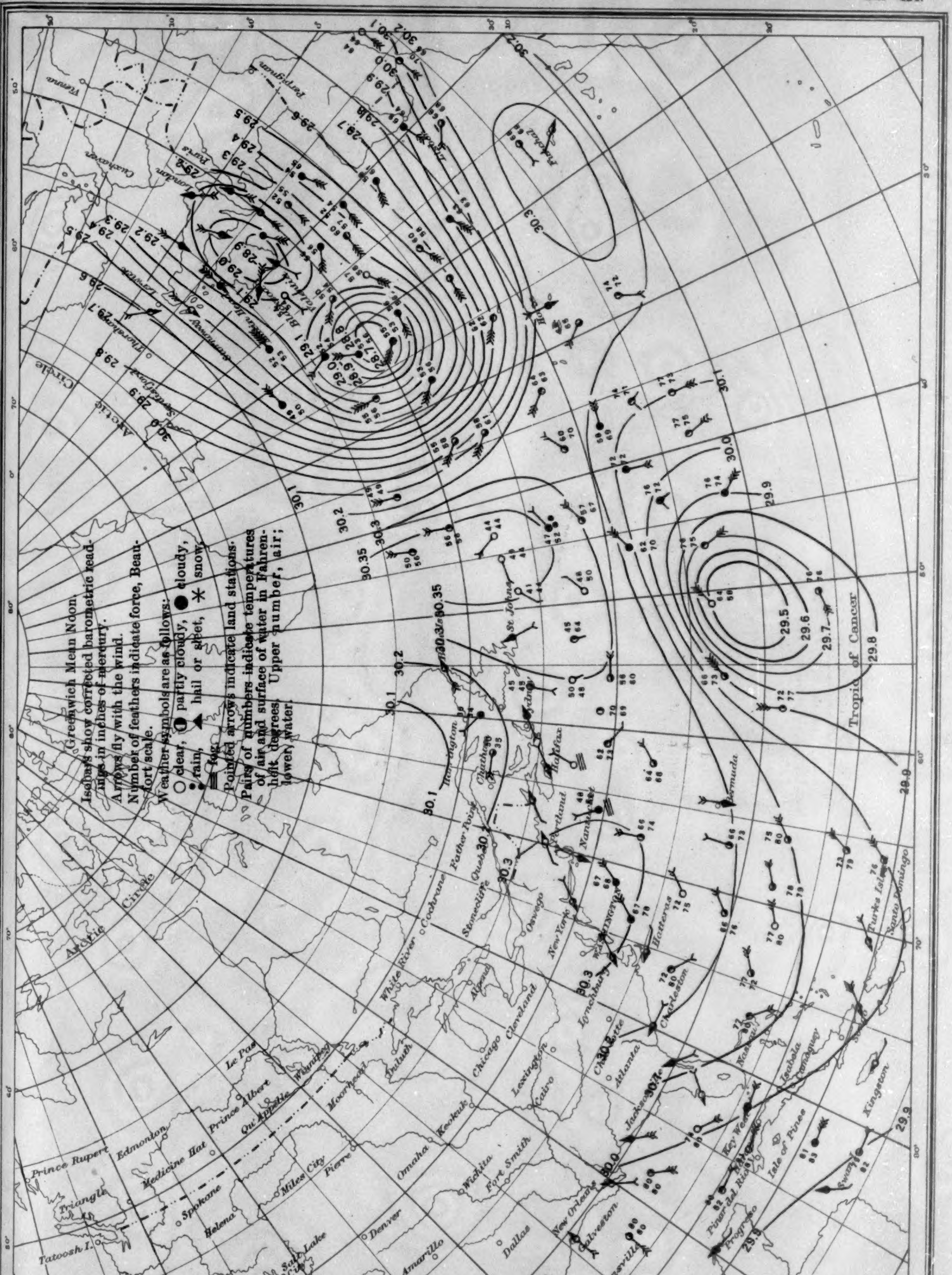
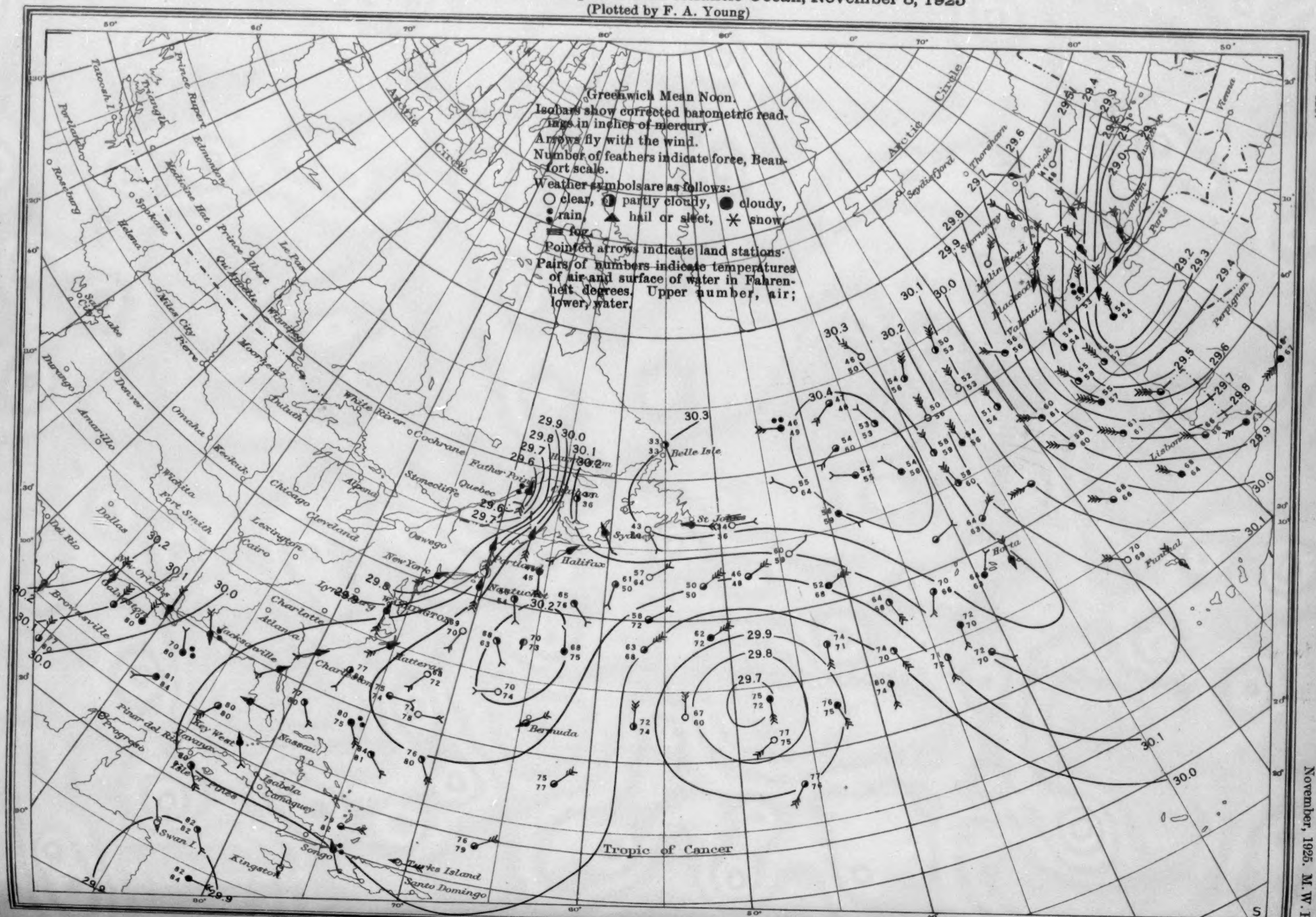


Chart X. Weather Map of North Atlantic Ocean, November 7, 1925
(Plotted by F. A. Young)

Chart XI. Weather Map of North Atlantic Ocean, November 8, 1925

(Plotted by F. A. Young)